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The Alberta Journal of Educational Research

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Editorial

In 1991 Tom Maguire, editor of the *Alberta Journal of Educational Research*, proposed to the Canadian Educational Research Association/Association canadienne des chercheurs en éducation the possibility of devoting a special issue of the journal to francophone research in Quebec. He said that in the opinion of many anglophones francophone researchers develop the theoretical context of their projects to a far greater extent than anglophone Canadians and treat certain classic subjects in an original manner.

The president of CERA/ACCE, C. Dufresne-Tassé, a francophone from the Université de Montréal, intrigued by the obvious differences between the scientific customs of the two groups of Canadians, agreed to co-edit this issue with another francophone, J. Désautels, from Université Laval. These guest editors invited articles from 10 Quebec researchers. These articles were to be written in French, evaluated, revised, and then translated into English.

Some of the authors of the articles presented here teach in universities in Quebec City or Montreal, others in regional universities. Some belong to large teams directed by five researchers or more, or even to research centers; others belong to more modest teams, and others work alone. However, it cannot be said that the 10 articles constitute a representative sample of the subjects studied by Quebecers, nor indeed of the latter's major concerns. At most they illustrate the manner in which these researchers work.

An examination of these texts largely confirms the intuitions that gave rise to this present special issue. But even more importantly, it reveals a series of phenomena that account for the characteristics of francophone research.

The 10 texts cite francophone and anglophone authors. Obviously, these articles are inspired by both European and American scientific trends. Sometimes they borrow their tools or their theoretical approach; sometimes they criticize the latter and offer alternative solutions.

This constant contact with foreign authors encourages collaboration between Quebec research teams and those from other countries, most frequently European teams. Indeed, cooperation with American research groups is extremely rare. Why is this? We cannot say.

Contact between Quebec and European teams, usually French, Belgian, or Swiss, take several forms, including the organization of symposia, funding applications, or collaboration in writing papers or books. This type of association is a source of great dynamism for Quebec researchers. For their part the Europeans consider that they thus gain privileged access to the work of North Americans.

These phenomena are likely to increase in importance. Because of the research networks that are springing up with the European Economic Community, Quebecers are now coming into contact with the work of their German and Italian colleagues and will certainly take inspiration from them as they already derive inspiration from the work of their colleagues in France, Belgium, or Switzerland. Moreover, because several teams in these latter countries have already established relations with South American teams, the

Quebecers are gradually becoming aware of research published in Spanish and Portuguese and, at the same time, the special issues of concern to developing countries.

Two factors are responsible for the intensification of these phenomena. The Fonds FCAR (Formation de chercheurs et aide à la recherche) of the government of Quebec has just developed an international section whose purpose is to support the development of functional and lasting links between Quebec and foreign teams. Several departments of Quebec universities encourage their students at the undergraduate and above all at the graduate and postgraduate levels to learn several foreign languages. The young researchers should therefore have greater access than their present colleagues to publications written neither in French nor English.

In a different vein, an already longstanding contact with authors who publish in English as in French has made Quebec researchers particularly aware of the errors made by unilingual writers in their interpretations of the work of foreign authors. The following is an example of some recent inaccuracies identified in the interpretation of Piaget's theory.

The problem is not simple, for Piaget produced a vast quantity of texts during a career that spanned over 60 years. His thought obviously evolved during that time, so that there is justification for asking "Which Piaget are we talking about?" However, despite an exceptional intellectual output, Piaget did not always write clearly and thus himself contributed, as von Glaserfeld (1987) points out, to muddying the waters and creating problems of comprehension. Despite these problems, certain interpretations of the cognition model proposed by Piaget are astonishing for example, the following taken from O'Loughlin (1992):

Using the biology of the digestive system as an analogy, Piaget proposed an alimentary model to explain the relationship between mental processes and incoming information, describing intellectual adaptation in terms of the dialectical balance between processes of assimilation and accommodation. (p. 794)

For anyone somewhat familiar with Piaget's writings, this interpretation of his cognition model is surprising. It should be noted first of all that even if this model is biologically inspired, it is totally incorrect to reduce it to an alimentary analogy. For proof one has only to read *Biologie et Connaissances* (Piaget, 1967).

The reader is completely disconcerted when O'Loughlin makes a comparison between the Piagetian model and that of incoming information, for Piaget has often stated that knowledge comes from a self-organizing construction process that is performed by the subject in his or her perpetual quest for balance in his or her interactions with the environment (either exogenous or endogenous). Does he not say "the environment contains no information. For there to be information, it takes more than the environment, the subject must focus his designs on objects to give them meaning" (Inhelder, Garcia, & Vonèche (1976, p. 59)? How can such misunderstandings be explained? It might be thought that the author is merely giving an empiricist interpretation of Piaget's constructivism, but this is not the case. The reason stems rather from the fact that O'Loughlin endorses without the customary precautions the

viewpoint of the authors to whom he refers, in this case Piaget's translators and critics.

The ability to read an author in the original text does not rule out the possibility of erroneous interpretations. The odds are that an empiricist of no matter what language will have Piaget say that the sources of a cognitive conflict lies in the environment! However, the advantage of a francophone researcher over a unilingual researcher of any other language is to have access not only to the original texts, but also to the vast literature produced around these works. It may also be reasonably supposed that the cultural affinity between francophone researchers in North America and researchers in France, Belgium, and Switzerland is such that they grasp the implicit dimensions of research produced abroad.

It may be asked whether this privileged access to Piaget's cognitivist-constructivist structuralism and to other forms of structuralism practiced by Levi-Strauss and Barthes has had a determining influence on Quebec researchers. Might this access have contributed to a less overwhelming adherence to the paradigms of positivism, which has for so long and so widely dominated the educational research scene in North America? Might it rather have fostered the emergence of a modified form of positivism or its hastier abandonment?

We cannot try here to give a formal response to these questions. However, an examination of the 10 articles presented reveals either the outright adoption of a quite different paradigm, positions of compromise such as the addition of individual dimensions to research designs that normally consider only social variables, or, finally, a far more radical position, the total abandonment after critique of the positivist paradigm.

Baby retraces the development of educational research in Quebec over the last 25 years. He describes the origins, places, organization, and funding of research, as well as the subjects and issues that have come to the fore. Beyond these facts, he notes the absence of tradition and epistemology specific to the educational sector and hopes that the pursuit of debate between the proponents of both the qualitative and quantitative perspectives will give fresh impetus to research. Thus he recognizes implicitly that the positivist paradigm has until recently exercised a considerable hold on the orientations of Quebec research.

The authors of six articles seem to have indisputably distanced themselves from the positivist perspective. Bergeron and Hercovics, basing themselves on the Piagetian constructivist perspective, propose a model for understanding mathematical concepts that, they say, enables them to follow step by step the child's construction of numbers from intuitive and logico-physical understanding to the formalization stage.

For their part, Bednarz, Dufour-Janvier, Poirier, and Bacon adopt a so-called socio-constructivist perspective in studying the elaboration of mathematical symbolism in children at the primary level; they believe that it is collectively through interactions and negotiations of meaning between the actors in the educational situation that a better informed and more reflective relationship to symbolism can be created in the student.

Zaïm-Idrissi, Désautels, and Larochelle situate their research within the radical constructivism line and try to show how biology students in the

master's program, trained according to the canons of empiricism, develop a mechanistic and deterministic representation of the concept of evolution, one that is omniscient and omnipresent.

Lebuis, Schleifer, Caron, and Daniel also place their research within a constructivist perspective and, following in Schön's steps, propose to encourage the development of a reflective type of educational practice in teachers through collaborative research around the theme of Philosophy for Children.

Daignault, taking a leaf from the analyses of Barthes who postulates the multiplicity of meanings of a text, proposes bridging the gap between the production of knowledge and its transmission within the university environment by transposing a text reading-writing strategy to the seminar, in order to transcend the divisions between speaking-listening and speaking-writing that characterize the customary pedagogical practices in this context.

Laflamme and Baby, when they address the subject of youth labor market integration, propose a psychosocial perspective of this phenomenon that differs from the rather mechanistic and deterministic versions of social reproduction through the use of the concepts of actor and field that they borrow from sociologists Touraine and Bourdieu respectively.

In two other articles, the authors adopt what we are tempted to call a mitigated form of empiricism. It is indeed within a psychosocial perspective that accords a central position to the actor that Dassa and Vazquez-Abad address formative evaluation and that Baillargeon, Betsalel-Presser, Joncas, and Larouche envisage the continuity of the experiences of the child in kindergarten who also frequents a day care service.

Finally, when he examines the theories on the effectiveness of organizations and the criteria derived from them to evaluate the latter, Brassard offers a severe critique of the empiricist perspective and proposes an approach where the actor's intentions play a primary role.

In our view, analysis of the 10 texts that we present reveals three phenomena of great importance for educational research. First, the fact that none of the authors participating in this issue has opted for pure positivism makes us wonder whether this abstention is due to the contacts that Quebecers have maintained with European researchers who have been working for years within other perspectives. To reply to this question, comparative studies must of course be conducted with other groups of researchers, particularly with English-Canadian researchers. During these studies, it would be important to establish with whom and according to what methods these groups of researchers establish relations of cooperation with other countries, as well as the effects of these links.

Second, real reciprocity is always the desired goal of cooperation between researchers of different countries. Knowledge of the methods used by French and English Canadians to achieve this goal, their comparison, as well as a comparison of the results obtained would be extremely useful. This knowledge would permit better use of the energies and funds devoted to scientific cooperation.

Third, if regular contact with American and European studies has been beneficial to Quebecers, it may be hypothesized that consideration of those of

their colleagues in developing countries will also have a stimulating effect. However, it is hard to predict exactly what this effect would be, for in this latter case the difference no longer seems to be one of paradigms, but a difference of issues.

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Jacques Désautels
Colette Dufresne-Tassé

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Educational Research in Quebec

This study begins with a brief history of the origin of educational research in Québec, first through the institutions established, then through the evolution of the overall research funding budgets. After briefly presenting the various centers of educational research, the author takes a closer look at the structure of research funding on which Canada's federal structure and the question of constitutional power sharing inevitably impact. The article concludes with an overview of the research themes and issues that reveal a fairly marked thrust toward applied research on solving problems raised by educational intervention in all its forms.

Cette étude débute par un bref historique de l'origine de la recherche en sciences de l'éducation au Québec, d'abord à travers les institutions mises en place, puis à travers l'évolution des budgets globaux de financement de la recherche. Après avoir présenté sommairement les divers lieux de la recherche en éducation, l'auteur insiste davantage sur la structure du financement de la recherche dans laquelle se répercutent inévitablement la structure fédérale du Canada et la question du partage des compétences constitutionnelles. L'article se termine par un survol des thèmes et problématiques de recherche dont on peut dégager une tendance encore assez marquée pour la recherche appliquée à la solution de problèmes soulevés par l'intervention éducative sous toutes ses formes.

A Brief History

The report on education published by the Conseil des Universités (1986a) states that generalization of the practice of educational research in Quebec and its institutionalization "go back scarcely 25 years" and that its development occurred in two stages, from 1964 to 1971, then from 1971 to the present day. As far as it goes, the analysis is accurate but it does not pay sufficient attention to the work of the pioneers who initiated major projects during the 1950s. Bélanger (1988) has rightly stressed that "the educational research movement, which gained momentum in the '60s and '70s, had been firmly set in motion in the preceding decade and that the mobilization of social science researchers for the implantation of new structures was its continuation." This viewpoint has the merit of giving a more accurate picture of the educational research movement and greater consideration to the fact that the enthusiasm that marked research generally throughout the '60s and '70s was due neither to chance nor to a phenomenon of spontaneous generation. In this matter as in many others, the glorious Quiet Revolution had ancestors, and the New Testament roots in the Old.

Bélanger recalls the research of Lauzon and more particularly that of the Tremblay group that pursued the ambitious project of demonstrating that the Quebec school system "reflected a traditional, rather than a modern and

technological, type of society" by studying a variety of themes and questions used as indicators, such as perseverance and dropout rates, demographic forecasts, aspirations and career choices correlated with social class and socio-economic status of the family, and so forth.

It is no exaggeration to think that the main trends observed at the time of these vast studies did more than merely foster reform. They also inspired many important aspects of that reform. Even though a certain approach to contemporary Quebec history suggests that these were the studies of pioneers, it must be acknowledged that few research projects since then have had so much impact and influence on the development of the Quebec educational system.

This said, it is fair to present 1964 as being an important year in the development of education in Quebec because it saw not only the tabling of the report of the Royal Commission of Enquiry on Education, known as the Parent Commission after its ecclesiastical president, but also the creation of a genuine Ministry of Education. That year must also be considered as a turning point, particularly as regards educational research in Quebec. From its inception, the new ministry gave priority to research, setting the example in a way by developing strong research units within its own Planning Branch. Subsequently, a number of the ministry's other branches would set up their own research services.

It was also the period that marked the disappearance of the normal schools and the transfer to the universities and their new educational sciences faculties of the mandate and exclusive responsibility for training the teachers needed by Quebec's new school system. This aspect of the reform, moreover, would have a paradoxical effect on the development of research in the following years. In principle, the broader mandate of the universities should have exercised greater pressure on university research simply because of the novelty and urgency of the situation and its related problems, as well as the increased demand and needs for research. In practice, such was not the case. In trying to analyze and understand this situation, the *Bilan du secteur de l'Éducation*, published by the Conseil des Universités (1986b), mentioned three possible factors to explain the slower pace noted at that time in the universities' research activities. First, professors overburdened by the sudden and sharp increase in the student population resulting from this new mission, finally had little or no time to devote to research, teacher training in the strict sense of the term constituting the priority of the moment. Moreover, this change of direction occurring within such a short space of time obliged the education faculties to absorb a large part of the teaching personnel of the normal schools. Most of these teachers had no training or experience to prepare them for research. Lastly, the research infrastructure of the revamped faculties was not stable or well developed enough to accommodate the double mandate of ensuring the professional training of teachers while simultaneously developing quality educational research.

This interim research stage was thus assumed by the Institut de recherche pédagogique (IRP), which until 1971 became not only the main source of educational research funding, but also, according to the Universities' Report,

“the real locus of research development, to the detriment of the budding faculties.”

In 1971, the beginning of the second educational research development phase, the Ministry of Education (MEQ) decided to limit its role as a research center and to entrust the task to the universities, CEGEPs, and school boards. The IRP closed its doors. Programs aimed at promoting the development and funding of research outside the MEQ were instituted. 1969 marked the beginning of the “Programme de formation des chercheurs et d’actions concertées” (FCAC). Then came the advanced training programs for French and math teachers and vocational training (PPMF, PPMM, PPMEP) that still exist. Another creation of note at that time was PARES (Program of Assistance to Research in primary and secondary education) that enabled many school boards to develop real research services. Most of these services survived, moreover, following the demise of PARES in the late ’70s. In 1981, the Programme FCAC became the Fonds FCAC, a more autonomous structure, less dependent on the Ministry of Education.

During this second period, educational research in the universities made a fresh start. Genuine research infrastructures were put in place: laboratories and research centers; research councils at the faculty and university level, and so forth. Advanced study programs were developing simultaneously at an accelerated pace as regards both numbers and personnel.

Thus the number of master’s professional degree programs increased from 23 in 1973-1974 to 50 in 1983-1984. However, the number of research programs increased a little less rapidly—from 22 to 38 during the same period. As for doctoral programs, the ideal level for research training, their number increased from 8 to 20.

During this same period, the numbers of students in advanced studies also increased substantially. At the doctoral level, they increased from 218 to 584, whereas at the master’s level they increased from 2,178 to 3,018 for the whole of Quebec.

What, one may ask, was the extent of research activities during this period and how did they evolve? From the indicators available, we select two: (a) the number of professors involved in various research activities; and (b) the funds allocated to research.

In 1969, two years after the demise of the normal schools and the integration of teacher training into higher education through the educational sciences faculties and other units, a survey carried out at the request of IRP (Pedersen, Dowd, & Faucher, 1969) showed that: (a) 58% of the professors of the education faculties had never carried out funded, sponsored, or free research; (b) that only 1% of the professors had more than 10 years’ research experience; (c) that scarcely a third of the professors spent more than 10 hours a week on research; (d) that only two professors out of five had research activities in progress at the time of the survey.

Ten years later, nearly two thirds of the professors of these educational sciences faculties and departments obtained at least one grant or sponsorship, and 87% of the professors had produced at least one publication meeting the requirements and criteria of the day. Further, according to the same survey,

61% of the professors had published at least one research report during the previous five years.

As regards research funding, a constant increase in the funds allocated was noted up to about 1983. Thus in 1979, the Programme FCAC alone distributed grants of \$1.1 million in the field of education. In 1983, the same program having then become the Fonds FCAC awarded research grants amounting to \$1.8 million. Since that time, the total funds allocated to educational research by the Fonds FCAC, which has now become the Fonds FCAR (the "concerted actions" having been replaced by "assistance to research": AR) have more or less held steady in absolute figures, which means that there has actually been a reduction in constant dollars. Thus Crespo and Lessard (1989) estimate that the Fonds allocated \$1.5 million to this research sector in 1985-1986, the same amount in 1986-1987, and \$1.6 million in 1987-1988. They also note that in 1987-1988, the total FCAR budget for all research fields including education and for all its programs declined by 8% in constant dollars compared with that of 1984-1985. As to the contribution of the Social Sciences and Humanities Research Council of Canada (SSHRCC) to educational research in Quebec, this also seems to have remained stable with no important fluctuations, at least in proportion to its total budget for all fields and Canada-wide. In 1984-1985, 0.4% of the total SSHRCC budget went to educational research in Quebec. In 1985-1986, this proportion rose to 0.8% and in 1986-1987, it stood at 0.7%. This approach is subject to caution, however, because it presents only one aspect of the SSHRCC's contribution scaled over time. Indeed, if we look at the absolute amounts of the grants allocated by the SSHRCC to education in Quebec during the same period, it will be seen that between 1984 and 1988 its contribution improved constantly, rising from \$290,382 in 1984-1985, to \$499,752 in 1985-1986, to \$509,938 in 1986-1987, and to \$691,542 in 1987-1988. This represents annual increases in its contributions of 172%, 102%, and 135% respectively taking 1984-1985 as the base year.

Some even more general figures give a better picture of the contributions made by the various research funding sources. Thus the report on the educational sector published by the Conseil des Universités (1986a) estimates that between 1979-1980 and 1983-1984, about \$24 million were devoted to educational research in Quebec. The specific contribution of the Quebec Ministry of Education (MEQ) to this sum through various special programs such as the PPMF, PPM, and PPMEP was more or less equivalent to that of the Fonds FCAR for the same period: \$7,612,00 compared with \$7,649,00. The same data indicate that the contribution from federal sources to this global sum was \$3 million, that is, 12%. The contribution of various private sources was about \$2.5 million, that is, 10.5%. If we consider only the contribution of agencies devoted exclusively to research funding for the period 1984-1988, Crespo and Lessard (1989) note that the Fonds FCAR gave \$6,368,000 in grants out of a total of \$8,700,000, whereas the SSHRCC gave \$1,991,614, that is, 22.7% and the CQRS, \$338,462, that is, 3.9%.

Centers of Educational Research and Research Training

During the last 20 years, the structure of the educational research and research training centers in Quebec changed considerably. On the whole, it can be said to have evolved toward a better harmonization of research projects and pro-

grams and better use of available resources. Today educational research is mainly carried on in seven different centers, two of these, as seen below, assuming no particular responsibility with regard to research training.

The Educational Sciences: A Clearly Identified Locus

One of the features of the development of the educational sciences in Quebec is the existence of structures clearly identified as teaching and research units, usually having faculty or departmental status. It is these units that constitute, and by far, the main centers of educational research. Most of the universities have specific educational sciences faculties or departments, as is the case of the following universities: Laval, Montréal, McGill, Sherbrooke, Concordia, UQAM, and most of the other components of the Université du Québec.

Other University Units

Educational research is also an important activity for a small number of researchers belonging to fundamental social science departments such as sociology, psychology, linguistics, even economics, plus the institutional research offices of most of Quebec's institutions of higher education. In these cases, the educational research activity takes the form of an applied field for studies and reflections of a more marked theoretical and fundamental nature. At the other extreme, we find institutional research offices in most of the universities. Their mission is to respond to the institutional research needs of each establishment.

Some Interfaces

Certain research structures act as interfaces where endeavors are made to synthesize and ensure the balance between theory and practice, the fundamental and the applied, educational psychology and the teaching discipline, the concerns of researchers and those of front-line interveners. This is the case, for example, of CIRADE (Centre interdisciplinaire de recherche sur l'apprentissage et le développement en éducation) at UQAM, or that of the interdisciplinary community services research center at Laval, although this is much smaller than the former, which is specifically geared to the educational field and functions mainly in the social and community intervention sector. This was also the case of the Education section of INRS (Institut national de la recherche scientifique), which lasted only a few years and disappeared in June 1986. More recently, CRIRES (Centre de recherche et d'intervention sur la réussite scolaire et l'insertion professionnelle) emerged at Université Laval and has undertaken important research on academic failure and school dropout. This center brings together in an original partnership investigators from the university's education faculty and researchers and practitioners from the CEQ (Centrale de l'enseignement du Québec), the Quebec teachers' union. The Université du Québec also has two research groups: GRAPO (Groupe de recherche multirégional sur les applications pédagogiques des ordinateurs) and GRES (Groupe de recherche sur l'enseignement supérieur). It is widely hoped that this type of educational research center will proliferate.

The Other Teaching Levels

We must not overlook the research endeavors and the quality of work that is done at the other teaching levels. At the primary and secondary levels, most of

the school boards have a research department where the researchers, often working under none too favorable conditions, are far from having at their disposal the resources available to their colleagues at the college and university levels. At the college level, where research has become an increasingly important activity over the years, researchers may have access in certain cases and under certain conditions to the same funding sources as university researchers. A formula that is becoming increasingly popular is that of the participation of college researchers in university research teams or that of the constitution of mixed teams.

Within the Ministries

We must also mention the considerable volume of educational research that is carried on in certain government ministries, especially in the Ministry of Education (MEQ), and in that of Higher Education and Science (MESS), as well as that of Manpower and Income Security (MMSR). The thrust of the research done in these departments, as well as the weight of the institutional research geared essentially to the organization's immediate needs and requirements, depends more than elsewhere on the generosity of research grants awarded, which in turn are particularly influenced by the economic situation and doubtless also by the government's own policies and priorities, which can be variable and unstable.

It should be noted that the last two research centers mentioned, namely the research departments of the school boards and CEGEPs as well as those of certain government ministries, have neither the mission nor the responsibility for research training. However, this does not prevent them from sometimes taking on students from the universities as trainee research assistants.

Advisory Bodies

A further category of research center also makes an important, well-established and highly appreciated contribution to educational research. This consists of the major public advisory bodies that have their own research service. In the research tradition, the oldest and best known is undoubtedly the Conseil supérieur de l'éducation (Superior Council of Education), an organization set up at the same time as the Ministry of Education, with the task of advising the Minister on all questions pertaining directly or indirectly to the Quebec school system, and that the Minister is obliged to consult on all important matters falling within his jurisdiction. Mention must also be made of the contribution to research of the Conseil des universités and that of the Conseil des collèges, which also have the responsibility of advising the Minister of Higher Education and Science on questions within their necessarily more limited competence. This list would not be complete without mention of the remarkable and unflagging contribution of the CEQ (Centrale de l'enseignement du Québec) to educational research.

In conclusion, here are some statistics from the report of the Conseil des universités (1986a) that give a fairly clear idea of the general thrust as regards the educational research centers. Thus, for the period covered by the report, that is, from 1979 to 1984, out of the \$24.5 million allocated to research projects dealing with educational subjects, \$19 million, that is, 77%, went to research units in the educational sciences and \$5.5 million to units other than the

educational sciences. However, if we consider the research that is carried out in the educational sciences units alone, 73.5% of the grants obtained concerned educational subjects, while 14% concerned subjects other than education, and 12% mixed or indefinite subjects. These figures all point to the relative homogeneity of the educational research centers in Quebec.

As regards research training as such, it is precisely through the channels of postgraduate studies that this is acquired. The master's student, after a specialized BA in one field or another of the educational sciences, is confronted with a choice between a type A master's degree based on courses and professionalization and a type B master's research degree. At the doctoral level, however, this American-inspired split is no longer to be found in the Quebec universities: they decided against retaining the DEd type of degree, that is, a doctorate in education, and to focus instead on the PhD, which is essentially a research training option.

For the student, this research training is acquired practically in four nonexclusive ways. While pursuing the activities of his/her program of studies as such that culminate in a research dissertation at the master's level and a thesis for the doctorate, students may also acquire part-time practical experience through part-time contracts as a research assistant, a job that is paid from either research grants or the universities' internal funds. They may also acquire this training from doing their own research or by joining a larger research group.

Structure of Research Funding

The different levels of government that characterize the Canadian political system have an impact on the structure of research funding. In practice in Quebec there is not just one but two research funding structures operating fairly independently of each other. The federal structure consists of three major councils, that of medical research (MRC), that of the natural sciences and engineering (NSERC) and that of the social sciences, which is the one from which the great majority of educational researchers seek funds. Certain sectors historically connected with the educational field (although that does not always and necessarily imply an organic or institutional link) also apply for funds to the two other councils: psychology, physical education and physical activity sciences, whose researchers may apply either to the NSERC or to the MRC under certain conditions.

Unlike the other provinces, Quebec also has its own research funding structure in the same way that it has its own taxation system. Originally, the Ministry of Education (MEQ) was itself the main provider of research funds. With time, the Quebec government created a structure that resembled the federal structure. There now exist three major agencies that enjoy a fair measure of autonomy as regards the management and distribution of the research funds entrusted to them. These organizations are the Fonds de recherche en santé du Québec (FRSQ), the Conseil québécois de la recherche sociale (CQRS), and the Fonds pour la formation des chercheurs et l'aide à la recherche (FCAR). One of the major differences between the federal structure and the Quebec structure lies in the fact that the Fonds FCAR is more diversified than all the other agencies mentioned. It covers all fields of modern research with the exception of research in the fields of health and social and community

work. If this aspect of the Fonds FCAR is combined with the fact that education is constitutionally a provincial jurisdiction, and that consequently, until not too long ago, the federal funds available for educational research were relatively modest, we have all the necessary elements in hand to explain why the Fonds FCAR, among all the funding agencies, is by far the most important provider of funds for educational research in Quebec.

The Fonds FCAR

The Fonds FCAR as it is today succeeded the Fonds FCAC in 1981. The essential difference between parent and child is one of emphasis and general orientation. While the Fonds FCAC (AC stood for *actions concertées*) stressed the necessity for public and private interveners as well as for research bodies to collaborate in defining research themes and priorities and in making use of the available resources, the Fonds FCAR (AR for: assistance to research) focuses on the need for public authorities to promote and assist research as such. It will be noted that the initials FC (for *formation des chercheurs*, researcher training) survived this change of direction. The Fonds' insistence on this mission was such that until 1989-1990 full-time research professionals or assistants with research funds obtained from the Fonds could not be hired because the "manpower" required for carrying out subsidized research projects was essentially constituted of master's or doctoral students enrolled in a full-time study program and devoting several hours of paid work a week to carry out the various forms of research required within the framework of the investigators' funded projects.

The Fonds FCAC had itself succeeded the Programme FCAC, which had originally been the direct responsibility of the Ministry of Education. This move gave the funding agency much greater autonomy in defining the guidelines for research in Quebec, as well as in the management of the resources available. For the years 1989-1991, the Fonds adopted two major goals (1986): (a) to maximize the development and scientific competitiveness of Quebec by focusing on excellence; (b) to promote training for advanced studies and scientific development through bursaries and incentives in the grants programs.

Over the years, the Fonds FCAR has set up eight different programs in order to try to satisfy the diversity of needs for research resources. Most of these programs aim to subsidize one aspect of research or another. The most important are: (a) support for research teams; (b) funds for research centers; (c) the establishment of new researchers; (d) concerted actions. In all cases, candidates submit an application for funds that is evaluated by a peer committee. The committee's recommendations are submitted according to an order set by the board of directors, which has the final say depending on the funds available. An additional program is one specifically related to research training objectives: postgraduate studies bursaries that are awarded on merit from study of the student's file.

The purpose of the support for research teams program is to create real teams undertaking research activity that is not only multidisciplinary, but also lasting and having structuring effects on a whole group of projects constituting coherent, comprehensive, and sound scientific programming. The guidelines adopted by the program aim to eliminate the fragmenting of ever-

shrinking financial resources in terms of constant dollars to cover ever-increasing needs. This program no longer funds what were previously known as projects. Projects are considered to be insufficiently comprehensive, too short, and without sufficient scope to justify setting up a reasonably durable and versatile research infrastructure. The team support program also closes the door to individual initiatives because the infrastructure for funding these is designed to guarantee the research a longer time frame and greater scope. On the principle that it is better to give fewer but more generous grants, the basic grant has been fixed at \$50,000 p.a. for three years. Various supplements can be added to this depending on the composition of the team and the complexity of the research program. Major grants are worth \$100,000 p.a. for teams of three to five investigators. Candidates for this funding program promise to apply for grants to other agencies, particularly those operating at the federal level such as SSHRCC, the funds allocated within the framework of the support program being considered by the Fonds as complementary infrastructure financing.

The grants to research centers program has become increasingly selective: it sanctions excellence and ensures a fairly comfortable infrastructure of human and material resources for new, advanced research. The aim is to attain a critical mass of at least six investigators released on a part-time basis for three- to five-year periods. Only one Quebec educational research center at present receives a grant within the framework of this program. This is CIRADE (Centre interdisciplinaire de recherche sur l'apprentissage et le développement en éducation) at UQAM. As regards the establishment of new researchers program, this is, as its name indicates, a program that gives new researchers a better chance of access to the funded research circuit.

The concerted actions program, for its part, is a thematic program that aims to encourage collaboration between the research sector and public bodies having considerable needs for research and expertise. These organizations are more often than not the Quebec ministries. For the moment, the program includes three different themes that are of only incidental interest to educational researchers: (a) the maintenance and rehabilitation of the road network; (b) road safety; (c) safety in sports. Because of recent adjustments, this program is now managed in somewhat the same way as the research centers program in that it gives fewer but increasingly generous grants. As in the case of the research centers program, a critical mass is sought of at least six investigators working half-time on research and justifying an infrastructure grant of at least \$250,000 per annum.

The Social Sciences and Humanities Research Council of Canada

Among all the Canadian and Quebec granting agencies, it is the SSHRCC that, after the Fonds FCAR, awards the most grants to educational research. The funds are mainly allocated through three programs: (a) standard grants; (b) major grants; (c) strategic grants. Unlike the situation prevailing in the Quebec programs, the federal agencies first submit applications to external adjudicators, experts in the field, before referring them to a peer committee.

One of the main features of the standard grants program is that applications are evaluated 70% on the investigators' curriculum vitae and past record and only 30% on the research program proper. Ten percent of the funds

allocated by the program are reserved for researchers who qualify as new researchers; in this case the proportions of the evaluation scale are inverted, that is, 30% for the CV and 70% for the research program as such. This recent modification in the program's guidelines constitutes a measure borrowed from two other federal agencies that have been functioning with this scale for a number of years. There are reasons for apprehension that this measure may well narrow the increasingly select circle of funded researchers. It introduces a draconian system. It will be increasingly difficult to obtain access to it. On the other hand, established investigators will find it easier to make use of it precisely because of the importance of their previous record. And woe to investigators who leave the program with one or two years of unsatisfactory performance behind them!

The amount of each grant is about the same as those awarded under the team support program of the Fonds FCAR, except that it is possible to obtain funding for five years instead of three.

The Major Grants program is designed for groups of investigators of approximately the same size as those funded by the FCAR's centers program. These are groups whose research activity justifies budgets exceeding the ceilings stipulated by the ordinary grants program, that is, over \$100,000 per annum, more than \$250,000 for three years, and more than \$400,000 for five years.

As regards the Strategic Grants program, this is thematic and has specific objectives including: (a) to facilitate the understanding of certain problems specific to Canada and to contribute to the formulation of government policies; (b) to encourage research in the field where there are shortcomings. In practice, this is research that must reflect and serve governmental priorities. The research themes are: (a) science, technology, and human values; (b) women and work; (c) organizational management in Canada; (d) education and work in an evolving society. Theme (d) is by far the one most often utilized by educational investigators. The budget constraints are the same as those of the ordinary grants program.

Le Conseil québécois de la recherche sociale

The contribution of this funding body to educational research is relatively modest. This can be partly explained by its nature and mission. The CQRS funds research that is primarily focused on social and community intervention. This research brings together researchers and front-line social interveners and its ultimate goal is to reduce the exorbitant social costs of such major issues in society as delinquency, violence in all its forms, mutual understanding and harmony among the ethnic groups, unemployment, poverty, homelessness, drugs, alcoholism, STDs, AIDS, and so forth.

Special Government Programs

It is also possible to obtain research grants from a number of special government programs at both the federal and provincial levels. At the federal level, government research funds are available for questions relating to the evaluation of employability measures, youth insertion, study maintenance, and so forth. As far as the Quebec government is concerned, advanced teacher training programs have already been mentioned. For some years now, these and

other similar programs contribute as much money to research as does the Fonds FCAR for the education sector. For instance, for the purpose of providing additional assistance to the teaching of French as the mother tongue, the MEQ has also set up a Plan d'action en français (Action plan in French) that offers grants for research on the question. Obviously, because of its objectives, this vast sector of educational research in Quebec consists essentially of applied research, and more particularly of development research.

Finally, a not inconsiderable proportion of educational research is done in the form of research contracts or sponsorships. These sponsorships, often accorded through tenders, usually come from the various government ministries having some kind of jurisdiction in the field of education. For instance, the Ministry of Education (MEQ), the Ministry of Higher Education and Science (MESS), the Ministry of Manpower and Income Security (MMSR), and so forth.

Research Themes and Issues

Educational research in Quebec has often come in for some harsh criticism. It has been said that it was fragmented, without roots or depth, without any scope or potential, not going much beyond individual projects and grants. These criticisms, though not unfounded, are generally flawed by not taking the context into account and by limiting themselves to criteria whose pertinence has not been established in this particular context. More detailed studies (Baby, 1988; Papillon, Rousseau, Tremblay, & Potvin, 1987) have shown the relatively contingent and economic nature of research in this field, its lack of autonomy, and its lack of objectivity with respect to the visibility of phenomena and events. It is, therefore, not without interest to try to discover more about its content, its basic thrusts, its recurrent themes, its strengths, and weaknesses over the years.

The few inventories that have been made on the question agree on at least one point. Most of the research done in this field consists of applied research bearing specifically on teaching, didactics, and learning. The report of the Conseil des universités (1986a) notes that, from 1979 to 1984 half the research in education concerned teaching as such, with 38% of this being in the didactics field alone.

Crespo and Lessard (1989) note, moreover, that 51.6% of 67 grants accorded to the educational sector in the framework of the research teams support program in 1989 were for studies addressing questions respecting teaching, didactics, and learning. As regards research dealing with the social aspects of education, most of the projects focused on the impact of socioeconomic factors and social class on various phenomena, particularly on aspirations, access to higher education, academic perseverance, and so forth. In school administration, it was mainly a question of research on systems management, as well as the training and career of school administrators. A small percentage of research (3.1%) addressed the question of intercultural education within a specific context, notably that of the greater Montreal region, where the topicality of the question and the urgency of the situation are clearly no longer in doubt. These data corroborated even more sharply a trend already noted in 1984, in the report of the Conseil des universités.

Other themes are also seen to emerge with increasing insistence and occupy an ever-increasing place in scientific symposia and meetings. Among these are children in difficulties of all sorts from the standpoint of a mainstreaming policy introduced by the MEQ several years ago. Or again the burning question of relations between the ethnic groups and that of intercultural education. A further emerging theme is the whole question of the social and professional insertion of young people into the labor market and that of the transition between school and work. For two years now, this research theme has been the subject of a special one-day symposium held during the annual conference of ACFAS (Association canadienne-française pour l'avancement des sciences). At the same time, a research group at Laval University (CREQIC) now emerging as a recognized university center and profiting from the creation of a pan-Canadian research network on professional insertion and career counseling, is gradually making its mark as the leader of francophone research on the question. Finally, within the framework of International Literacy Year, there has been a more marked interest in research on the various aspects of this theme.

For their part, Dandurand and Ouellet (1990), in a careful review of research dealing more specifically with sociology of education issues, identified five major research thrusts in this sector:

1. access to education;
2. education and employment;
3. school policies;
4. the impact of school organization on socialization and learning;
5. the teaching profession.

The first two topics are apparently the most popular. The first, which was already exciting much interest at the time of the school reform in the '60s, still drains most of the resources and efforts in the sociology of education sector. As to the second topic mentioned above, it is probably the situation created by the ongoing economic crisis and endemic unemployment that has rapidly placed it in the forefront of present-day research.

For Dandurand and Ouellet (1990), the third and fourth topics, which still interest a good number of investigators, should arouse particular interest and experience considerable development during the coming years. The fifth, which concerns the largest category of educational personnel, is, in spite of its importance, somewhat neglected. Dandurand and Ouellet, who made a systematic search of some 20 scientific journals over a 10-year period from 1976 to 1986, express the hope that the sociology of education will give priority to the analysis and evaluation of educational policies from different viewpoints, thus better integrating a "sociology of power that will reveal more clearly the dynamics of the forces operating on the educational scene."

In the same research-on-research theme, that of Papillon, Rousseau, and Tremblay of the Université du Québec à Rimouski, and Potvin, of the Université du Québec à Trois-Rivières (1987) whom we cited above, is one of the most interesting and complete that has been done recently on educational research in Quebec. Moreover, because this is a multidisciplinary research, it deserves special attention. The authors made a careful study of 121 research projects conducted or in progress during the year 1984 in the educational

sciences departments of the various components of the Université du Québec. To analyze the content of these projects, a certain number of variables or dimensions of the projects were selected, such as target population of the projects by age, years of schooling, learning situation, object of study, types of research, research paradigms adopted, and so forth.

We recall here the most significant findings with regard to the contents, themes, and issues of these research projects. Examining the target populations of these numerous studies, the study shows that 35% of them were children, 22% teenagers, and, curiously enough, 38% adults. Thirty percent targeted the primary level, 30% higher education, 25% the secondary level, and only 1% the college level. According to learning situation, 12.5% of the studies were related to children with learning difficulties and 87.5% to teenagers presenting no special problems.

The analysis by objects of study gives more fragmented results and does not necessarily agree with the findings of the Conseil des universités. Thus the most important focus of all these research projects is the field of measurement, evaluation, and research methods, a topic to be found in 25% of the projects. Next in order come the following topics: the psychological foundations of education: 18%; programming in general: 16.9%; administrative problems: 10.4%; then specific programming and teaching: 9.1%. It should be understood that the categories of Papillon et al. that are closest to the "teaching, didactics and learning" category so popular in the studies of the Conseil des universités (1986a) and of Crespo and Lessard (1989), are those of "programming in general" and "specific programming and teaching."

Only 1% of the projects inventoried had as their topic the philosophy of education or the social foundations of education or, again, the analysis of educational policies.

The study then examines the interesting category of the paradigms adopted by the different projects. This category first requires some explanation. The authors have used the paradigm classification established by Bertrand and Valois (1982). This comprises five paradigms:

- the rational paradigm, where a highly structured education is oriented toward the transmission of predetermined knowledge;
- the techno-systemic paradigm, which focuses on the effectiveness of instruction with regard to its social, cultural and political ends;
- the humanist paradigm, which represents a subjective and existential person-centered approach;
- the institutional paradigm based on the Marxist vision of society;
- the inventive paradigm, which stresses that the individual has importance only through the existence of other individuals and, in the final analysis, through the existence of the universe.

In fact, the first, the rational paradigm, is by far the most popular in educational research, since it recurs in 87% of cases. The techno-systemic paradigm is used in only 8.9% of cases, and the humanist paradigm in 3.8% of cases. Thus in this field there seems to be a sort of tacit agreement among the researchers, at least those of the Université du Québec. No study invokes either the institutional paradigm or the inventive paradigm.

Finally, a breakdown of the projects studied by type of research used parallels the observations already made: very little basic research (16.5%) and a great deal of applied and development research (74.6%). Not only on account of the richness of the information it provides but also because of the clarity and simplicity of the research design, this type of meta-research should be replicated, and on a wider scale, to include, for instance, all Quebec universities.

In spite of a proportionally major research effort, we have to conclude that not everything has been said or done. Much is lacking. Certain studies have indeed indicated shortcomings, flaws, themes that seem absent from the researchers' concerns, and wrongfully so, either because of their intrinsic importance or simply because of their great topicality and social pertinence. Among these themes is obviously the important question of the socio-educational context of learning, a sort of preamble to an institutionalized sociology of knowledge and whose absence had been noted in both the Conseil des universités' study (1986a, 1986b) and by that published three years later by Crespo and Lessard (1989).

Another theme that is practically absent is that of the analysis and evaluation of educational policies from different viewpoints and on different questions: policies on mainstreaming, young immigrants, academic performance assessment policies, staff and institutional evaluation policies, school board funding policies, and so forth. The urgency must also be stressed of studies on the history of education and the school system, on the evolution of the currents of educational philosophy and pedagogical doctrines in Quebec and elsewhere, the influence of these doctrines on Quebec education, and on comparative education in general.

Epilogue: Noticeable Absences and Perspectives

Even if we succeeded in filling in all these gaps, the mass of data thus constituted could not offset the impact of two noticeable absences: a tradition and an epistemology specific to the educational sector that would be inspirational and regenerative and to which educational research proper has for the moment but indirect access via borrowings from the other older and better established social sciences such as sociology and psychology. A significant fact in this regard is that the great names in education have so far been those of thinkers, philosophers, even doctrinarians, rather than researchers and scientists in the usual sense of the words.

The whole combination of the elements of this present situation finally prompt us seriously to challenge the very status of education as a discipline and as a field of research. They justify basic questions often couched as a balance sheet. For instance, must a certain balance be sought between research *in* education and research *on* education. Is there not at the present time a certain imbalance in favor of the first of these two basic research orientations? Does a genuine science of education exist? If not, is it legitimate to hope that it can exist one day? Is not the present status of education as a field only a transitory status situated somewhere between that of art and science? Obsessed by the prestige and hierarchies of the genuine sciences, have we not simply confused *technique* as a set of processes of an art with science as such, and have we not called science what is really but a technique? If our research has often appeared as a search for the efficacy of processes, does this mean that

there is no real science at the service of an art, but simply one or more techniques? And, finally, is not art the transitory status of a rapidly evolving corpus on the highroad toward science considered as the nirvana of all human activity?

Of course, we are not in a position to reply to such questions in any sort of pertinent and lasting manner. However, in the present situation of Quebec educational research, there exist new givens that are highly promising in this respect. These new factors might even enable research to make a giant step forward during the coming years. And the recent development most likely to generate this kind of epistemological chaos is undoubtedly the adherence of a large number of educational researchers to the movement of qualitative research. This new movement is being implanted with sufficient vigor to challenge even the stability and legitimacy of the all-powerful positivist empiricism and one of its most illustrious offspring, American social pragmatism. For the moment, there is no need to worry that this dialectical relationship emerging between diverse scientific communities sometimes looks very much like a power struggle or battle for hegemony. On the contrary, it can be hoped that this basic movement, which sometimes approaches the incommensurability of Feyerabend's theories (1979), or even the shift and encounter of paradigms as postulated by Kuhn (1983), can have beneficial effects on the development of educational research in Quebec by forcing the two clans to clarify their positions, consolidate their roots, spell out their strategies, in short acquire more maturity, more tradition, more strength and breadth.

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An Epistemological Study of the Child's Construction of Early Arithmetic

This article conveys our epistemological approach to research in mathematics education. Such an approach leads us to view mathematical knowledge in terms of conceptual schemes, that is, cognitive networks and the problem situations to which they apply. The development of models of understanding enables us to translate a conceptual scheme into a cognitive matrix. This has proved to be the theoretical basis of our study of the kindergartners' construction of number. This research was carried out in three countries. The cognitive numerical structures found in each group were surprisingly similar despite the differences in language and culture. Our data also indicate that even at this early age an enriched program of mathematical activities can have a significant impact on the children's mathematical development.

Cet article décrit l'approche épistémologique utilisée dans nos recherches en didactique des mathématiques. Une telle perspective nous amène à concevoir la connaissance mathématique en terme de schèmes conceptuels, c'est-à-dire des réseaux cognitifs ainsi que les situations-problèmes auxquelles ces schèmes s'appliquent. L'élaboration de modèles de compréhension nous permet de traduire un schème conceptuel en une matrice cognitive. Ceci a constitué la base théorique de notre étude de la construction du nombre par les enfants de maternelle. Cette recherche a été menée dans trois pays. Les structures cognitives numériques découvertes dans chacun des groupes d'enfants se sont avérées étonnamment semblables en dépit des différences de langue et de culture. Nos données indiquent aussi que, même à ce jeune âge, un programme enrichi d'activités mathématiques peut avoir un impact significatif sur le développement mathématique des enfants.

Introduction

For the last 12 years our research group has been studying problems related to students' construction of school mathematics. Both the development of our theoretical framework and our research methodology have been strongly influenced by major European and American schools of thought. For instance, our need to start right from the beginning with an epistemological analysis of

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the mathematical concepts under study followed in the footsteps of Bachelard's work on epistemological obstacles, Piaget's studies in genetic epistemology, and Vygotsky's theories regarding the importance of pedagogical interventions. On the American side, although not agreeing with the information processing movement's assumption that the computer model can describe the functioning of the human mind, we nevertheless recognized the importance and role that procedures play in the conceptualization of mathematical concepts. Regarding our methodology, we have retained from the Genevans the clinical method that enables us to probe the student's thinking in greater depth; the Soviet school brought us to a form of intervention, the teaching experiment, "primarily directed at disclosing and elucidating the very process of learning, as it takes place under the influence of pedagogy" (Menchinskaya, 1969, p. 89). On the other hand, we have been open to North American criticism regarding any generalization based on the restricted use of these methods to a few case studies. This is why we have developed semistandardized interviews and prepared detailed teaching outlines that have given us the opportunity to perform intersubject analyses. Furthermore, many case studies were carried out in order to ascertain the most frequent forms of thinking.

Our first concern was to develop a theoretical framework powerful enough for the epistemological analysis of elementary mathematical concepts. This proved to be essential because classical concept formation theory could not be used to describe the construction of fundamental mathematical concepts. For instance, even for a seemingly simple concept such as number, one cannot imagine teaching it by discussing its attributes or providing examples and non-examples. Any analysis reveals that mathematical notions involve extensive knowledge that the student must be able to connect and organize in a cognitive network in order to achieve understanding. We have used the expression *conceptual scheme* to translate this idea of a cognitive network that we define as a network of related knowledge together with the problem situations where it can be used (Bergeron & Herscovics, 1990). In an attempt to regroup all the knowledge involved in the construction of conceptual schemes we have developed models of understanding (Herscovics & Bergeron, 1983, 1988).

Over the last few years we have refined the criteria used to identify the different elements involved in the notion of understanding mathematics. These elements are what constitute a model of understanding that can be used as a frame of reference for the analysis of various conceptual schemes. For instance, it forces us to find answers to questions such as "What is meant by an intuitive understanding or a procedural understanding of early addition?" Once the analysis of a conceptual scheme has been completed, one must design specific tests and develop an appropriate form of questioning in order to assess students' knowledge and understanding.

We have followed this sequence in dealing with various conceptual schemes such as early addition and multiplication, fractions, notions of length and area, integers, points and straight lines in the plane. In particular, we have used this sequence to study kindergartners' construction of number, because this age proves to be a critical period in their intellectual development. Children from Canada, France, and the United States were involved in this study.

We now describe and justify our model of understanding, and then apply this model to the number concept, describe certain tasks, and report results of the international study.

Description of Understanding

It is not enough to recognize that understanding is the key to learning mathematics; one must be more specific about its meaning. Models used 20 years ago now appear somewhat simplistic. Indeed, some of them were limited to a dichotomy (understands or does not understand) whereas others reduced understanding to the correct use of rules. In order to account more appropriately for the complexity of the phenomenon and to integrate the results from prior research, we were influenced by Piaget’s genetic epistemology in designing a model better suited for describing the understanding of conceptual schemes in mathematics. In the 1980s, the data we gathered led us to several revisions of our model in order to achieve greater precision in our descriptions (Herscovics & Bergeron, 1983, 1988).

The latest version of our model embodies the idea that for children understanding a mathematical concept is built up from preliminary physical concepts whose construction involves three distinct stages, namely, intuition, procedural understanding of a logico-physical nature, and logico-physical abstraction. Only through a process of mathematization of these physical precepts is the mathematical concept constructed; its understanding also involves three components: procedural understanding of a logico-mathematical nature, logico-mathematical abstraction, and formalization. The structure of this model warrants it being called a two-tiered model of understanding (see Figure 1).

The distinction between a first tier that deals with preliminary physical concepts and a second tier related to the emerging mathematical concepts reminds us of Piaget’s (1974) distinction between *simple* or physical abstraction related to the properties of objects, and *reflective* or logico-mathematical abstraction based on the coordination of actions and operations. However, when actions and operations are carried out on sets of concrete objects, this distinction is no longer as clear cut. In fact, Piaget was aware of this, as shown in the following:

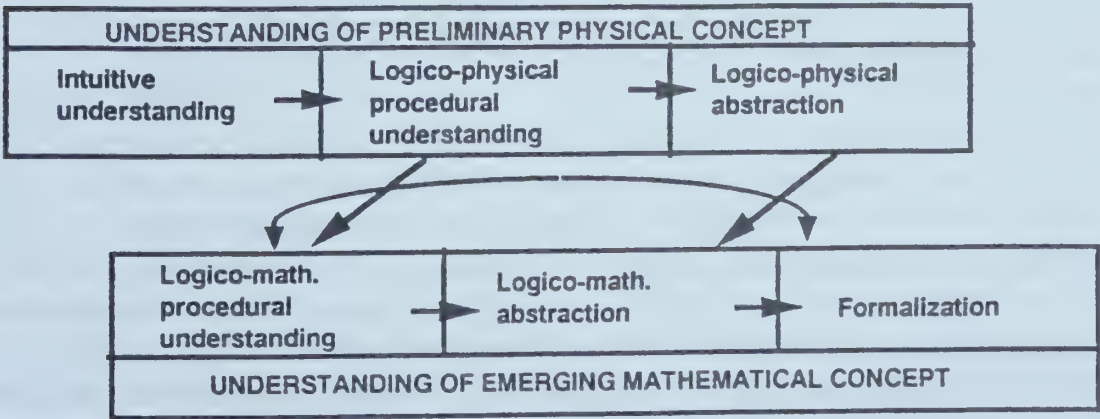


Figure 1. The two-tiered model of understanding.

We will speak in this case of “pseudo-empirical abstractions” since the information is based on the objects; however, the information regarding their properties results from the subject’s actions on these objects. And this initial form of reflective abstraction plays a fundamental psychogenetic role in all logico-mathematical learning, as long as the subject requires concrete manipulations in order to understand certain structures that might be considered too “abstract.” (p. 84, our translation)

When Piaget mentions obtaining the information from the objects and the need for concrete manipulations, he brings out the physical origin of some mathematical notions. However, one can quite well manipulate sets of concrete objects and perform on these several transformations without necessarily involving mathematical objects. For instance, a child who adds three marbles to a given set knows without any doubt that there are now more marbles than before. Only when the question “How many?” is raised does this become a mathematical problem. This is the reason we distinguish between, on the one hand, procedures and abstractions of a logico-physical nature, and, on the other hand, procedures and abstractions of a logico-mathematical nature, depending on the physical or mathematical nature of the objects used. The arrows in Figure 1 express the nonlinearity of the model.

First Tier: Preliminary Physical Concepts

Intuitive understanding refers to a global perception of the notion at hand; it results from a type of thinking based essentially on visual perception; it provides rough nonnumerical approximations.

Procedural understanding refers to the acquisition of logico-physical procedures that the learners can relate to their intuitive knowledge and use appropriately.

Logico-physical abstraction refers to the construction of logico-physical invariants (as in the case of the various conservations of plurality and position), or the reversibility and composition of logico-physical transformations (e.g., taking away is viewed as the inverse of adding to; a sequence of increments can be reduced to fewer steps through composition), or as generalization (e.g., perceiving the commutativity of the physical union of any two sets).

Second Tier: Emerging Mathematical Concepts

Procedural understanding of a logico-mathematical nature refers to the acquisition of explicit logico-mathematical procedures that the learner can relate to the underlying preliminary physical concepts and use appropriately.

Logico-mathematical abstraction refers to the construction of logico-mathematical invariants together with the relevant logico-physical invariants, or the reversibility and composition of logico-mathematical transformations and operations, or as the generalization of certain arithmetical properties.

Formalization suggests the idea of *mathematical form* that can be differentiated from mathematical content. It also refers to its usual interpretations, that of axiomatization and formal mathematical proof, which at the elementary level could be viewed as discovering axioms and finding logical mathematical justifications respectively. Two additional meanings are assigned to formalization: that of enclosing a mathematical notion into a formal definition, and that of using mathematical symbolization for notions where procedural under-

standing or abstraction already exist to some degree. This last condition is essential to avoid considering pure memorization as understanding.

Application of the Model to the Understanding of Number

Well before children can answer the question "How many?" they can recognize if they are in the presence of one or several objects. We refer to this notion of nonnumerical quantity as *plurality*. Similarly, long before they can determine the rank of an object in an ordered set, they can also decide if an object in a row is situated before or after another one, if it is the first or the last one. This amounts to a nonquantified expression of the notion of *position*. Only when the quantification of the notions of plurality and position is involved does the concept of number emerge and take on a cardinal or an ordinal meaning according to its context. In this sense we define cardinal number as being a measure of plurality and ordinal number as a measure of position. Consequently, plurality and position can then be considered as preliminary physical concepts or preconcepts of number.

Starting from these teleological definitions, which are based on the uses of number, we have developed tasks and questions enabling us to evaluate kindergartners' knowledge and comprehension of it. We have interviewed about 30 children in each of the three cities: Montreal ($N=32$, average age 6:2), Paris ($N=29$, 5:8) and Cambridge, MA ($N=30$, 5:10), in order to determine if, independently of their mother tongue (French or English) and their culture (European or North-American), the same numerical structures could be found among children living in cities where the same environmental influences are present (games, children books, television, etc.). Among American subjects, we had the opportunity to include children from regular kindergarten classes where no explicit mathematics program was present, and a group of children who were involved in activities based on the Mary Baratta-Lorton program *Mathematics Their Way* (1976). Whereas the first group was essentially limited to counting activities, the second group was regularly involved in a great variety of arithmetical activities. The Montreal children came from two schools located in higher socioeconomic suburbs, and from two schools located in low to average socioeconomic neighborhoods. The latter were comparable from a socioeconomic viewpoint to the classes selected in Cambridge and Paris. Such variety in our groups was needed to reveal the impact of socioeconomic background, maturation, and pedagogy. All the children retained for this study were considered of average ability by the school authorities, and each was interviewed three or four times for about 30 minutes each time.

First Tier: Preliminary Physical Concepts

Intuitive Understanding

To evaluate intuitive understanding, we used tasks where success essentially depended on visual grasp. Thus for the notion of plurality we laid out two sets of chips in front of the children to verify if they could judge which had *more*, had *less*, or if they were *equal*. For the notion of position we used a row of small wooden horses of different colors and then asked if a certain horse was *before* another one (or in front), *after* another one (or behind), if two horses were *side by side* (or were running together), if a horse was *between* two others, and

finally, to point out the *first* and the *last*. Because the success rate varied from 84% to 100%, this indicates clearly that the notions examined have been acquired at that age. Nevertheless, we found that some confusion still remained between the temporal context (before) and the spatial context (in front), and thus a certain flexibility was required in questioning the child.

Procedural Understanding of a Logico-physical Nature

Procedural understanding of a logico-physical nature can be distinguished from intuitive understanding by the fact that certain precise procedures must be acquired if one is to accurately answer the questions raised above. And, of course, because we are concerned here with the precepts of number, we must look for nonnumerical procedures that do not rely on any counting. In fact, setting up a one-to-one correspondence between sets of objects is a non-numerical procedure that children use spontaneously.

In a cardinal perspective all children using this procedure could generate an equivalent set and then a set where "there were more." Generating a row where "there were less" was more difficult, results varying between 86% and 97%. Some children do not seem to distinguish yet between "more" and "one more." Curiously, this last question would seem to be more difficult as shown by the following success rates: in Cambridge, 100% for the children in the Lorton classes (following a special program based on Baratta-Lorton, 1976) and 64% for those in the regular classes; in Paris, 72%; and in Montreal, 81% for the pupils in the lower to average socioeconomic neighborhoods and 94% in the wealthier ones.

To evaluate procedural understanding of the notion of position, eight wooden horses of different colors were placed in a row and an identical set given to the children who had to align theirs along the first row, so that their red horse was to "come along at the same time as my black horse (to precede, to follow)." Our results show that most of the children interviewed knew how to use a one-to-one correspondence to generate the required ordered sets. All but two could generate the first row, whereas for the second task (to precede) the success rate was 100, 94, 86, 100, and 100 respectively, and for the third task (to follow) 94, 79, 79, 100 and 100.

Logico-physical Abstraction

One aspect of the logico-physical abstraction of plurality is characterized by its invariance relative to certain spatiotemporal transformations performed in front of the children so that they remain convinced that no object has been taken away or added. In this study, eight tasks were used. In order to verify the influence of the space occupied by the objects, we dispersed them, then brought them closer together, while asking if there were "more, less, or the same as before." To find out if simply moving the objects could influence their perception of plurality, a few chips were displaced without modifying the occupied space. To assess the effect on plurality of a change of perspective, we rotated a plate of chips. To assess the effect of the length of a row on plurality, we used the classical Piagetian test where two rows of chips are put in one-to-one correspondence, after which one of them is lengthened. In order to verify if in the previous task the children's judgment might be influenced by the presence of a shorter row, we used a simpler task where only one row was

used, and then lengthened. To find the effect of the nonvisibility of some objects of a set, we put two rows of chips in a one-to-one correspondence, then part of one row was hidden from sight. To find out if in the previous task the children were influenced by the presence of the completely visible row we repeated the same task, but with only one row. Table 1 presents the success rate in percentages.

Globally, these results seem to indicate some similarity among the five groups. With few exceptions, if we overlook differences smaller than 10% because the number of pupils in each group is small, we observe the same hierarchy. It is almost perfect for the two groups that are more advanced, the pupils from the Lorton classes and those from the higher socioeconomic level in Montreal. The low rate of success of the Parisian children on the tasks where a row was lengthened could be because they were two to six months younger than the others. If the invariance of plurality with respect to rotation and with respect to the displacement of objects in a given space can be considered as acquired by a majority of pupils, the tasks involving dispersion and contraction show that for two of the groups, 30% to 40% of the children are still influenced by the space occupied by the objects. Comparable success rates on the Piagetian test were obtained by children from the Cambridge regular classes and from the Montreal less favored groups. On the other hand, for the latter as well as for the young Parisians, 25% to 45% of them thought that, even in the presence of one single row, after lengthening its plurality has changed. Finally, the tasks involving hiding part of a set reveal for the first time how important the visibility of objects remains for the plurality to be grasped at that age. A comparison of the average success rates of the two Cambridge groups indicates a 16% difference in favor of the pupils in the Lorton program. Of the two Montreal groups a 17% difference favors the children from the higher socioeconomic level. The middle three columns represent the low to middle socioeconomic groups not following any mathematics program. The

Table 1
Success Rate in Percentages on Tasks Related to the Abstraction of Plurality

	Cambridge		Paris	Montreal	
	Lorton N=16	Regular N=14	N=29	S.ec. – N=16	S.ec. + N=16
<i>Invariances relative to</i>					
Rotation	100	86	90	88	100
Displacement	100	93	79	81	94
Bringing closer together	100	100	69	63	88
Lengthening—1 row	100	93	55	75	88
Dispersion	94	79	66	69	88
Piagetian test	100	57	24	50	81
Hiding part of—1 row	31	7	28	0	19
Hiding part of—2 rows	25	7	7	0	6
Average percentage for 8 tasks	81	65	52	53	70

Cambridge regular classes score better than the other two groups by 12% to 13%, but again, due to the small number of children involved, not too much importance can be assigned to these figures.

The logico-physical abstraction of position is also characterized by its invariance relative to certain spatiotemporal transformations. In order to evaluate it, three tasks were used. To find out if the distance between an object and the head of the row influenced the perception of position, we stretched out a row of eight wooden horses and asked the child if the position of a given one had changed. To verify the effect of the nonvisibility of some of the objects in a set, we slowly "inserted into a tunnel" a sheet of cardboard on which nine trucks of different colors were drawn and asked the same question as before. We also designed a task somewhat parallel to the Piagetian test of conservation of plurality: Two parallel rows of nine identical cars placed in one-to-one correspondence were "to cross a river" on a ferry that could accept only one car from each row at a time. The sixth car from each row was marked with a small arrow and then the two rows were set off through displacement of each row by a different length. The children were then asked if the two cars with the arrows would cross the river at the same time.

Table 2 presents the success rates, which show an identical hierarchy for the five groups. Comparing with the results obtained for plurality, we notice an average decline of some 22%. This could be because notions involving position are rarely introduced in school. The gap observed for plurality between the two Cambridge groups has increased for the notion of position (from 16% to 31%), whereas it has diminished from 17% to 11% for the two Montreal groups. Lengthening a row seems to have a greater impact in an ordinal context than in a cardinal one. In fact, comparing the lengthening of only one row in the two contexts, and excluding the Lorton children who had 100% success rates in both cases, we observe for the four other groups an average decline of 21%. On the other hand, for the partially hidden row, the results are quite the opposite. Thus excluding the Parisian group, which went down from 28% to 21%, for the other four groups there was an average increase of 34% when comparing the cardinal with the ordinal context.

Finally, a task was aimed at the integration of the notions of position and plurality. Differently colored cars were placed in a row and then the front car was removed in front of the child. The effect of this transformation was then verified by questioning the subjects about their understanding of the rank of a given car in the row. Could they perceive that by changing the plurality of the cars preceding the designated one, its position would be necessarily affected? The success rates for the five groups, given in their usual order, were 86, 88, 86, 88, and 94% respectively. These results show that even at this early age an integration of the two notions exists.



Figure 2. Two rows of cars crossing a river.

Table 2
Success Rate in Percentages for Tasks Related to the Abstraction of Position

	Cambridge		Paris	Montreal	
	Lorton N=16	Regular N=14	N=29	S.ec.- N=16	S.ec.+ N=16
<i>Invariances relative to</i>					
Lenthening—1 row	100	64	38	56	69
Hiding part of—1 row	69	29	21	31	63
Translation	31	14	14	25	13
Average percentage for 3 tasks	66	35	24	37	48

Second Tier: Emerging Mathematical Concepts

Procedural Understanding of a Logico-mathematical Nature

As mentioned above, only when counting is involved can one really talk of number. Of course, any counting act implies a one-to-one correspondence between two sets. However, in counting the correspondence is no longer between two sets of concrete objects, but rather between a set of concrete objects and the set of counting words—one, two, three—which then become mathematical objects.

The need to set up a correspondence between objects and counting words is why counting is more complex than the simple act of recitation. We gave the children a set of 75 chips and asked them to count these as far as they could. We conservatively retained as the upper limit of their knowledge the number that preceded the first discontinuity in their correspondence. For the five groups of children, in the usual order, we found that on average they could count up to 71, 54, 32, 37, and 45 respectively. These results are surprising because they reflect extensive counting skills, which are even more pronounced for the two Cambridge groups.

Mastery of other counting procedures was also studied. We ascertained whether children could recite the counting words starting from a given number. Even in the younger group half the children could start from 12 whereas three quarters of them succeeded when starting at six. To find out what meaning they attached to this counting-on procedure, the following task was used. A piece of cardboard, on which 11 chips were glued, was inserted into a partially opaque bag, so as to hide the first four chips; a small arrow was then placed in front of the sixth and the following question was asked: "Here is the sixth chip. Can you continue counting from the sixth?" Only afterward did we ask them how many chips were in the bag.

We also checked if the children could count backward. Many could recite the number word sequence backward starting from 10 or higher, and still more of them succeeded when starting from a number between five and 10. This procedure proved to be necessary in order to succeed on the following task. A sheet of cardboard on which 12 chips were glued was inserted into a partially opaque bag that hid the first three chips; a small arrow was then placed in front of the 10, followed by the question: "Here is the 10 chip. Would

you show me the seventh one?" For the children who could only count backward from six, two chips were hidden, and the sixth was pointed out while asking for the fourth.

Table 3 shows the success rate. These results are quite unexpected. Whereas the first row in the above table indicates that on average 95% of the children can count on from a given number, the second row shows that only 35% of them connect the last uttered word with the cardinality of the set. This highlights the gap that can exist between the acquisition of a procedure and the meaning it may have. Three conjectures could explain these results: (a) perhaps at this age children still need to establish a one-to-one correspondence between all the objects in a set and the counting words to feel that they have "counted" them and thus be able to answer the question "How many?" (b) perhaps the nonvisibility of part of the set sways their judgment; (c) perhaps starting from an ordinal situation, they encounter difficulties in returning to a cardinal context.

The gap reported above is again found in backward counting. Taking the success rates in counting back from 10 for the two Cambridge groups and starting from six for the others, we see that on average 90% of the children can count backward. Nevertheless, the average drops to 41% for those who use this procedure in the proposed task. Of course, one should not make a negative inference by concluding that they cannot use it. But they certainly do not apply it. A plausible conjecture is that these children have learned backward counting in the context of rocket launching (—, three, two, one, zero, blast-off), and not in problem solving situations.

Logico-mathematical Abstraction

Stability and reproducibility of counting. Because we have defined cardinality as the measure of plurality, the invariance of cardinal number implies the in-

Table 3
Success Rate in Percentages on Counting Procedures

	Cambridge		Paris	Montreal	
	Lorton N=16	Regular N=14	N=29	S.ec.- N=16	S.ec.+ N=16
<i>Can count</i>					
starting from a given number	100	86	97	94	100
And know how many chips altogether	50	14	41	44	25
<i>Can do backward counting</i>					
starting from 10	100	100	41	56	69
starting from 6			62	88	100
And can find the rank of the 7th (4th)	69	29	24	38	44

variance of plurality together with the invariance of its measure relative to some spatiotemporal transformations of sets of objects. In a more limited sense, for counting to become a measure of plurality the procedure itself as well as the result of its application have to be stable and reproducible. This may seem evident to an adult, but as Ginsburg (1977) has pointed out, young children may count the same set many times and get different results without any feeling of contradiction. Piaget (1973), as well as Gelman and Gallistel (1978), report that some children do not perceive the invariance of the cardinality of a set relative to the order in which the objects are counted.

To find out if our children perceived the uniqueness of the cardinality of a set, we had them count a set of 12 cubes, and then told them that another child had found there were 11. Could both be right? In each of the three cities, only one child believed that both answers were possible. Thus the uniqueness of the result of counting seems to be acquired at this age.

We indirectly verified if the children perceived the invariance of cardinality relative to the order in which the objects are counted. After they had counted a row of 12 cubes, we asked if they would get the same number by counting them in the opposite direction. The percentage of children who predicted the result without feeling the need to count them again was 88, 86, 69, 56, and 81 respectively. These results must be interpreted with care, because some children start counting as soon as they hear the words "How many?" whereas others do it to show that they are right. Certainly others count again because it is the first time they face this question and so are not sure of the answer. For this reason we used this task a second time with a row of 10 cubes. The percentage of children who did not need to count in the other direction increased to 100, 93, 86, 81, and 100 respectively.

Plurality and quotity. In the early 1960s, Piaget's collaborator Gréco (1962) felt the need to distinguish between "number" and "quantity." He modified the original conservation task involving two equal rows of chips. Because this test did not involve counting, Gréco used it again, but this time he asked the children to count one of the rows before stretching the other. He then asked how many chips were in the elongated row while screening it from view. He found that three quarters of the five-year-olds claimed there were seven chips in each row but that the elongated row had more. To Gréco, these children conserved *quotity* without conserving quantity (in our words, without conserving plurality). Conserving *quotity* simply meant that they conserved the numerical label associated with the elongated row, but their count was not yet a measure of plurality, because they thought the plurality had changed. It is only when both plurality and *quotity* are conserved, when both invariances are perceived, that number becomes a measure of plurality. Only then can one claim that the child has achieved a logicomathematical abstraction of cardinal number. We verified this notion of *quotity* in four of the tasks previously used for the conservation of plurality (lengthening a row, dispersion of a set, Piagetian test, nonvisibility of part of a row), but this time the children were asked to count before any transformation was performed. Table 4 shows the results.

Position and ordity. An entirely analogous approach can be used to describe the logicomathematical abstraction of ordinal number. Similar to the notion of

quotity, one can introduce its parallel in the context of position. We define ordity as the ability to conserve the numerical label associated with the position of an element in an ordered set subject to various spatiotemporal transformations. And, of course, some children perceive the invariance of ordity without perceiving the invariance of position. Only when both are present can one claim that counting results in the measure of position and that the child has achieved a logicomathematical abstraction of ordinal number. To study this notion of ordity, the three tasks used for the logicophysical abstraction of position were repeated, but this time before any transformation was made the children were asked to determine the rank of a designated object (found by counting). The results are shown in Table 4.

As Gréco (1962) observed, we found a phase difference between the conservation of plurality and the conservation of quotity. Comparing the average success rates in Tables 2 and 4 for the lengthening a single row the average increases from 82% to 89%, a difference of 7%; in the case of dispersion it goes from 79% to 88%, a difference of 8%; for the Piagetian test from 62% to 84% with a change of 22%; finally, for nonvisibility of part of a row a change from 17% to 67%, resulting in a 50% difference. In each case the invariance of quotity rates higher than the invariance of plurality. As might be expected, because the great majority of children were conserving plurality for the first two tasks, the difference there was minimal. The opposite occurs for the last two tasks. In nearly all cases the children who conserved plurality also conserved quotity. However, as is almost always found in any thorough educational study, results are never totally clean. Indeed, we found that on some tasks a few children were conserving plurality without conserving quotity.

Comparing Tables 3 and 4 we note a difference between the invariance of position and that of ordity. For the task where a row was lengthened, the average goes from 65% for the invariance of position to 88% for the invariance of ordity resulting in a change of 23%; for the nonvisibility of part of a row, we obtained 43% to 54%, with a difference of 11%; last, for the translation of the

Table 4
Success Rate in Percentages on Quotity and Ordity

	<i>Cambridge</i>		<i>Paris</i>	<i>Montreal</i>	
	<i>Lorton</i> <i>N=16</i>	<i>Regular</i> <i>N=14</i>	<i>N=29</i>	<i>S.ec.-</i> <i>N=16</i>	<i>S.ec.+</i> <i>N=16</i>
<i>Quotity with respect to</i>					
Elongation—1 row	94	79	83	100	88
Dispersion	100	71	86	81	100
Piagetian test	100	86	72	75	88
Hiding part of—1 row	88	71	21	75	81
<i>Ordity with respect to</i>					
Elongation—1 row	100	86	72	81	100
Hiding part of—1 row	75	43	34	44	75
Translation	75	64	62	63	69

two rows of cars the average increases from 19% to 67%, a difference of 48%. For the three tasks conservation of ordity is better than that of position.

The importance of context is evident here. Comparing the differences obtained in the lengthening of a single row, we observe a change of 7% for the cardinal context and 23% for the ordinal task; for the nonvisibility of part of a row 48% for the cardinal and only 11% for the ordinal context. Finally, comparing the test results on the Piagetian test with those on translation, the difference goes from 22% to 47%.

Variability of rank. Recalling that in assessing the children's perception of the variability of the position of an object when changing the number of objects preceding it in a row (the row of cars whose first one broke down), we had found success rates of 86, 88, 86, 88, and 94% respectively. The same task was proposed again, but this time the children were asked to find the rank (by counting) of a designated car (the sixth). After we took away the head car and then hiding the row, they were asked to state the new rank of the designated car. The percentages of children who deduced that it must now be the fifth one were 81, 36, 55, 63, and 88% respectively. Whereas the pupils from the Lorton classes and those from Montreal classes in high socioeconomic suburbs succeeded well, the other three groups averaged 87% on the variability of position and 51% on the variability of rank, a decline of 36%. How can this be explained considering that in general quodity and ordity precede cardinality and position? Surely the problem cannot be attributed to a lack of knowledge of an appropriate procedure because most of these children can count backward. A likely hypothesis is that the ordinal and cardinal aspects of number have not yet been integrated.

Formalization

Numerical message. By formalization of number we mean understanding mathematical writing, that is, the different notations used. In a sense, one can claim that writing formalizes the number concept by giving it a graphic form. We studied children's spontaneous use of written symbols through the following task. Seven small cardboard fir trees were laid out randomly in front of them. They were given paper and pencil and asked to "leave a message for a friend" to tell him how many fir trees were there.

On the basis of preceding studies, messages in several different forms could be expected. The most primitive involves drawing a corresponding number of images of the objects (D); the use of tally marks (M) is somewhat more abstract, as it no longer conveys the image of the objects; some children answer the question by writing 1, 2, 3, 4, 5, 6, 7. Resorting to this sequence of numbers (S) is more advanced, as it actually reproduces the counting procedure; finally, the use of only one numeral to convey the cardinality of a set (C) demonstrates that the child no longer relies on this one-to-one correspondence between the objects and the counting words because the numeral now summarizes the counting procedure. The results appear in Table 5.

It is evident that the idea of a numerical message has been well understood by almost all children, as only three subjects from the youngest group did not know what to do. A look at the first two rows of Table 5 shows that, globally, 78 of the 91 subjects (86%) spontaneously used numerals to communicate the idea of number, and that 59 of them (65%) assigned to the numeral seven its

Table 5
Percentage of Students: (1) Using Different Forms of Numerical Messages,
(2) in the Different Writing Ranges

	Cambridge		Paris	Montreal	
	Lorton N=16	Regular N=14	N=29	S.ec.– N=16	S.ec.+ N=16
<i>1. Kind of message left</i>					
Only one numeral (C)	81	86	52	44	75
Sequence of numbers (S)	6	14	28	44	6
One tally mark for each object (M)	0	0	7	0	0
Drawings of the objects (D)	6	0	3	13	19
No message left	0	0	10	0	0
<i>2. Write up to</i>					
<10	-	-	55	38	24
10-19	25	43	45	50	56
20-30	75	57	0	12	25

cardinal meaning. The young Parisians as well as the children in Montreal schools situated in low-to-average socioeconomic suburbs still frequently used the sequence of numerals. Altogether, only 10 children (11%) relied on drawings or marks. Obviously, by the end of kindergarten understanding of written numerals is remarkably evolved.

Writing numbers. In order to assess their ability to write numbers, we asked the pupils to write down all the numbers they knew. To our great surprise, some could write them up to 50 or 60, and this took much time, such that we stopped them when they exceeded 30. Having written their numbers, they were then asked to read them aloud to confirm that they recognized their writing. The results appear in Table 5. We found that many pupils (73%) could write two-digit numbers. Of course, this does not mean they understood place value notation, that is, knowing that the 1 in 12 stands for 10. Kamii (1977) found that only half of grade 3 children are aware of it. Ginsburg (1977); has shown that long before they understand this notion children can recognize and write numbers above nine, which implies an apprehension of positional notation.

We have identified three levels in the understanding of positional notation. At first, numerals placed side by side take on a global meaning 12 does not mean "one and two" any more, but rather twelve. However, children do not yet realize the importance of relative position and they might just as well believe that 21 is another way of writing 12. We call this level of understanding that of juxtaposition. When they realize how important relative position is, they can nevertheless neglect the intended message and focus on the sequence of writing the numbers. For example, when asked to put down 12 by writing from right to left, they will say "twelve" while writing "21," having first written 1 and then 2. We designate this level of understanding as chronological because it focuses on the order of production. Finally, when the relative position of numerals is no longer affected by the direction of writing, when the

children will write twelve as 12 in any direction, they will then demonstrate a level of understanding that we qualify as being *conventional*.

To determine their level of understanding positional notation, we asked the children to write their numbers from right to left. We found that the different levels of understanding were not mutually exclusive. For instance, more advanced pupils who could write numbers beyond 20 could be at the chronological level for numbers in the teens, and at the same time be at the juxtaposition level for numbers in the 20s. For those who could write two-digit numbers, we found that on average 18% of them reversed some numbers in the teens, and 11% reversed some in the 20s while writing normally from left to right, and thus were still at the juxtaposition level. The right-to-left writing has shown that on average 82% of the children were focusing on the production aspect, and so were judged as being at the chronological level. It is surprising to find that even at the kindergarten level 18% of pupils manifest an understanding of the conventional form of writing numbers.

Conclusions

The International Study

Our study of the kindergartners' construction of number is the most comprehensive ever made. In contrast with other research, we did not limit ourselves to the study of a particular aspect of its emergence, for by dealing with this fundamental notion as a conceptual scheme we had to take into account all the relevant knowledge. For each child, three or four interviews proved sufficient to sketch a profile of his or her numerical knowledge. Moreover, in each group a simple determination of the success rate suggested a hierarchy of the different tasks used in assessing the various aspects of understanding. Remarkably, if we put aside the results obtained on the effect of elongation among the youngest pupils, we essentially find the same hierarchies in each group.

At the first tier, dealing with the understanding of the precepts of number, we found quite advanced intuitive and procedural understandings of plurality and position. By studying the logicophysical abstraction of these concepts we discovered the strong impact that visual perception still has on the child's thinking. In six of the eight tasks used for plurality, and in the three tasks used for position, we found that spatiotemporal transformations quite strikingly affected their apprehension of invariance. This is especially true for the three comparable groups, the Cambridge regular classes, the Parisian children, and the Montreal groups from the low-to-average socioeconomic suburbs. The nonvisibility of part of a set seems to affect them most in the conservation of plurality and position. The unequal translation of two rows of cars seems to have had a greater impact on the notion of position than the effect of the Piagetian test on the conservation of plurality.

At the second tier, mastery of counting skills seems to be well established. However, even if the children know how to count on from a given number, our results show that many do not necessarily link the last word pronounced to the cardinality of the set. As for backward counting, they do not seem to use this procedure to find either the number of chips hidden in a row or the rank of a chip that precedes a designated one. Such results answer some questions relevant to mathematics education for they show that one cannot teach proce-

dures out of context without the inherent danger of voiding them of relevance and meaning. This is also reflected in terms of logicomathematical abstraction, because conservation of quantity and order generally precede conservation of plurality and position. We can only consider quantity and order as measures of cardinality and ordinality whenever the invariance of their precepts has also been achieved. That some children have not yet completed the integration of the cardinal and ordinal aspects of number is evidenced by the fact that some of them could not find the new rank of a car in a row where the head car had been removed. Finally, at the level of formalization, we found that these children had acquired a surprising amount of knowledge. Many could already write two-digit numbers. Although most were still at a chronological level of understanding of positional notation, many even demonstrated an understanding of the conventional rules of writing numbers.

Two of the variables that we took into account contribute to a discussion of the roles of maturation and of environment. For the two Montreal groups our results show that on most tasks children from schools in high socioeconomic suburbs achieved a higher success rate than those from schools situated in less favorable neighborhoods, neither group being involved in any specific program of mathematical activities. Many factors could explain this result: the stability of the family, the quantity and quality of food, the competence of teachers, the available instructional material, and so forth. The data obtained from the two Cambridge groups clearly show that the children following the Lorton (Baratta-Lorton, 1976) program outscored the others on all tasks. This observation might be considered self-evident, as obviously teaching generally leads to some acquisition of knowledge. What is so surprising is that these differences are quite pronounced, even at the level of logicophysical abstraction where the notions of invariance cannot be taught because they result from individual reflection involving the internalization and reversibility of actions. A plausible explanation is that the multiplicity and variety of activities bring these children to think for themselves.

Theoretical and Methodological Considerations

We believe that an epistemological approach opens new avenues for research. Such an approach compels us to reconsider what is meant by "understanding" and to reflect on the necessary conditions for learning to occur. Furthermore, it enables us to gather parcels of knowledge into conceptual schemes, global structures whose construction extends over several years. The model of understanding we suggest can provide a framework in which to follow any evolution in the children's constructions. And because these constructions may vary among pupils, this model of understanding cannot be transformed into a prescriptive model of instruction. Although we have presented the components of understanding in a linear fashion, this does not necessarily reflect an individual's specific construction. We have tried to show in Figure 1 this nonlinearity by using arrows linking the different components. As far as methodology is concerned, we found that only an individualized dialogue with the children could enlighten us about their thinking and the procedures and strategies they used. The use of semistandardized interviews enabled us to identify the most frequent thinking patterns, while leaving us free to explore interesting paths during our questioning. Regarding the analysis of

results, many possible links between the components still have to be untangled. For instance, it seems evident that a certain level of abstraction is essential if counting on from a given number is to become a meaningful procedure. The same is true for the formalization of number because it may also have an impact on abstraction.

Pedagogical Implications

Our approach has several pedagogical implications. On one hand, an epistemological perspective used for the analysis of mathematical concepts may have a significant impact on teachers by affecting their conception of mathematics, their perception of its construction by children, as well as on the cognitive impact of their pedagogical interventions. The very structure of the model explicitly links the children's mathematics to their physical world and thus strongly suggests using the latter as a starting point in the construction of their mathematical concepts. One cannot overemphasize the importance of this approach, for Ginsburg's work (1977) has brought to light the gap that may exist in children's minds between school mathematics and informal mathematics acquired outside school. With its two tiers, our model encompasses the two forms of knowledge.

Its use in the analysis of conceptual schemes brings out several aspects of understanding that are often neglected in instruction. For instance, few teachers or textbooks assign to the ordinal aspect of number the importance it deserves; logicomathematical procedures are often introduced prematurely, thus neglecting the need for a prior development of the logicophysical procedures; activities that may provide the children with the possibility of achieving some degree of abstraction at both tiers are usually ignored. Following the analysis of a conceptual scheme, teachers should be able to develop tasks related to each aspect of understanding. They could thus present the children with a far broader range of activities whose complementarity would provide a much richer cognitive environment.

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Socioconstructivist Viewpoint on the Use of Symbolism in Mathematics Education

The function ascribed to symbolism in teaching today, clearly related to a Platonic vision of mathematics, differs from the important role it has played in the development of mathematics as a communication and conceptualization tool. The alternative proposed in this research, carried out in a class of young children, is based on a different conception of mathematics and learning, viewed as both an individual construction and a social practice, and establishes a new, more informed, and more reflexive relationship to symbolism on the children's part.

La fonction que l'on fait jouer au symbolisme dans l'enseignement actuel, intimement liée à une vision platonicienne de la mathématique, s'écarte du rôle important que celui-ci a joué dans le développement des mathématiques comme outil de communication et de conceptualisation. L'alternative qui est proposée dans cette recherche réalisée en classe avec de jeunes enfants s'appuie sur une conception toute autre des mathématiques et de l'apprentissage, conçues à la fois comme une construction individuelle et comme une pratique sociale, et met en place un nouveau rapport au symbolisme plus averti et plus réflexif de la part des enfants.

Questions concerning the use and contribution of symbolism in mathematics teaching cannot be considered separately from the purposes associated with the act of symbolization. The approaches we adopted with regard to different concepts of mathematics and teaching ascribe a quite different role to symbolic representations. Before describing this approach, we first refer to the role usually ascribed to these representations in teaching by identifying the theoretical assumptions of such a use and explaining the problems that it creates for the student.

Use and Function of Symbolic Representations in Mathematics Teaching Today

Symbolic representation is a broader term than *symbolism*: it refers to a certain symbolic organization (oral or written natural language, diagrams, illus-

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tration, symbols, etc.) designed to account externally for a given situation or phenomenon or, in mathematics teaching as now practiced, an external mathematical reality to be transmitted. Mathematics teaching makes abundant use of these symbolic representations to enable the teacher to communicate a certain mathematical content and/or support to the students' learning process (Dufour-Janvier, Bednarz, & Bélanger, 1987). What expectations, often implicit, justifying such use can we trace from their authors' intentions?

For many authors, symbolism constitutes an essential element of mathematics whose vocabulary and grammar must somehow be learned. Symbolism thus becomes an integral part of the notion or situations studied. This use is common in mathematics teaching at different educational levels where practices focusing on certain elements of knowledge are based on a set of symbols often considered by the teacher as an integral part of the material taught. Others view symbolism as an aid to better understanding a concept in all its many aspects. Still others again regard symbolism as a support for the better understanding or handling of a situation. But what is it really? When we examine the roles attributed to these symbolic representations in teaching, a number of important elements come to light: the abusive use of often meaningless symbolic representations (Bednarz, Bélanger, Boileau, & Janvier, 1981), the imposition on the student of external and predetermined representations without taking into account the interpretation the latter is asked to give them, and the introduction of a symbolism often viewed as a language to be learned.

This current teaching trend gradually leads the student to conclude that mathematics consists in the manipulation of more or less meaningless symbols. This phenomenon, described by Brousseau (1986) as a metadidactic shift, and which can be noted from the language employed by educators, programs, or textbooks, consists in the transformation of a means of teaching or of understanding a particular item of knowledge into a teaching object. The symbolism thus loses its proper function of communicating a certain mathematical idea and of support for its comprehension that should be its role, and instead of a tool becomes an object manipulated without any reference to meaning and underlying situations.

The theoretical assumptions of such a use, whether related to the communication of a certain predefined mathematical reality, the understanding of a concept in all its many facets, or a given language whose grammar must be learned, take us back to a viewpoint that sees the architecture of mathematics as a preexisting reality that the student must somehow gradually discover. This concept leads to the teaching of knowledge in its definitive form and organization with the danger, as seen above, of its use being solely formal and meaningless. Learning is seen as the ever more controlled appropriation of a preexisting symbolism often confused with a certain external mathematical reality that it endeavors to convey.

What Problems Does Such a Use Create for the Student?

The research we have been conducting for several years in different fields concerning the problem raised by these representations in mathematics education (Bednarz & Dufour-Janvier, 1991; Bednarz & Janvier, 1984a; Dufour-Janvier et al., 1987) proposes a severe diagnosis regarding this use. Indeed, analysis of the interpretations given by the children in the study to these

multiple representations reveals the gap that clearly separates them from their authors' intentions. They also show us the small effect they have on learning. Indeed, the children seem to have a harder time understanding and learning how to use an external representation (table, diagram, graph, illustration, etc.) than performing the task with which the latter is associated.

Observation of the problems the children encounter in interpreting these representations and the small use made of them in problem solving suggests that we are moving away from the dual role of support and instrument of reasoning that symbolism should play in learning mathematics. These observations have led us in a quite different conception of mathematics and its learning to wonder what contribution symbolic representations developed by children might play.

A Constructivist Alternative to this Use of Symbolism

Research conducted from a constructivist viewpoint, as Ernest (1991a) himself observed in a recent critique on this subject, covers a panoply of theoretical positions. Some of these, stemming from a trivial type of constructivism, try to combine a concept of learning that involves active construction of the subject with student use of predefined external representations, running counter to such a theoretical stance. This is the situation of research proposing, for example, an approach to numerical calculation that stresses a direct correspondence between the stages of the written algorithm and its representation using material or illustrations and that assumes the existence of certain mathematical relationships "that could take form" in this external representation (Fuson, 1985). "Here a transparent instructional representation of place value notation is assumed to be the primary basis from which students construct mental representation of performed numerical relations" (Cobb, Yackel, & Wood, 1992, p. 4)

Learning is viewed here, of course, as a process where the children construct certain internal representations that, however, reflect the mathematical characteristics of predefined external representations resulting in a paradox hardly compatible with a theory of constructivist knowledge.

Research taking a nontrivial viewpoint, moreover, has often been limited to the study of the student's knowledge of construction mechanisms, and in some cases to the development of didactic strategies encouraging such construction. Based on the students' concepts and strategies in situ, these studies have often neglected the signifiers involved in this process (Vergnaud, 1985). Thus, even if the type of relationship to knowledge changes in the pedagogical approaches instituted by these researchers, it reproduces the same teaching patterns with respect to the established language, the latter being either added on or not even considered in this process. In our view, the constructivist perspective cannot be reduced to this interpretation. As regards not only the content but also the language that conveys this content, it assumes another type of relationship—more informed and more reflexive.

We have adopted this approach for several years in teaching strategies developed with children (Bednarz, 1992; Bednarz & Janvier, 1984b, 1988; Bednarz, Poirier, & Bacon, 1992; Dufour-Janvier, & Bednarz, 1989). The role ascribed to symbolic representations proves different from the one usually assigned to them, and we have described this at length above. Indeed, the

latter are in no way seen as a way of accessing certain preexisting mathematical relationships, but rather as a tool constructed by the subject that can give an account of a developing mathematical activity. Few studies have adopted this approach (see Brousseau, 1972; Schubauer-Léoni & Perret Clermont, 1980). In the didactic strategies developed, the symbolization activity is seen as both an individual and collective construct, a viewpoint deriving partly from an epistemological analysis of the role that symbolism has played in the development of mathematics and partly from a conception of learning based on didactic situations theory (Brousseau, 1986).

Before explaining our procedure from examples taken from the analysis of a current research project, we return to these basic considerations.

The Role of Symbolism in the Development of Mathematical Thought

The history of mathematics shows us the fundamental role symbolism has played in the development of mathematical thought, participating not only in the clear and precise formulation of problems and reasoning, the role usually ascribed to it, but also in the creation of new concepts and problems (Bailhache, 1978). We show briefly how this status of symbolism has evolved over time in relation to the very concept of mathematics. The analysis helps to reveal the constructed nature of these symbols, and the inextricable link between the cognitive and the social that marks their production, by replacing the conditions of their evolution within a system of wider beliefs and convictions legitimizing their use (Ernest, 1991b).

From a study of the history of mathematics we can retrace the important periods in this evolution of the role associated with symbolism. Mathematics in the Hellenic period is a case in point. Influenced by Plato, and subscribing to an idealistic conception of the nature of mathematics, mathematicians of the time liked to argue about pure notions and ideal essences, never deigning to consider tangible objects. In the relationship they established with mathematical knowledge existing in the world of essences, symbolism could play a merely secondary role. Thus, although the mathematicians of this period did make occasional use of certain symbols, they gave them only a designatory role, serving merely to reproduce these ideas in order to evoke and communicate them to others.

From a mere codifying support for transmitting certain ideas to others, symbolism, as we now see, was gradually to become an essential tool supporting reasoning and helping to create new concepts and new fields of study such as algebra.¹ This development began as early as 300 AD with Diophantes. The use he was to make of symbolism in solving specific problems created a new role that marked an important conceptual change in the way to approach problem-solving (Radford, in press). From a way of thinking that had proceeded thus far by synthesis starting with the known moving gradually toward the unknown, the language of symbolism opened the way to a new mode of analytical thought by accepting consideration of the unknown values of the problem right from the start and treating them as if they were known values. Symbolism thus permitted the fixing of new ideas, and thus the creation of new "mathematical objects" (it was the start of the notion of the unknown and the construction of a new language: that of algebra).

Several centuries would pass, however, before the works of Diophantes were rediscovered and found an echo; indeed, rhetorical algebra widely dominated the texts of the Arabic mathematicians. With Viète (1591) came a new turn. Symbolism was gradually to become a tool that, by disengaging itself from a specific problem, enabled a similar category of problems² to be tackled. From a mere tool for solving specific problems, the latter was to become a tool for expressing general solutions. Symbolism permitted algebra to widen its field of application, freeing complex problem solving methods from restriction to special cases. It would gradually lead algebraists to an interest in the structure of problems rather than in their particular form.

The above analysis illustrates the important role symbolism has played in the development of mathematics, elaborating new ways of thinking in the solving of specific problems, and in gradually developing a new field of study.

From an essential tool supporting reasoning, its status changed once more to occupy an ever greater place by gradually dispensing the mind from “thinking” the concepts it handles. This change would not go unchallenged. The conflicting positions that emerged with regard to this new role ascribed to symbolism in mathematics were clearly expressed in the discourse of Descartes (1596-1650) and Leibniz (1646-1716), who particularly marked the history of notations.

Descartes’ explanation of the functions of symbolism in the mathematical process shows clearly, contrary to what Leibnitz proposed some years later, that symbolism cannot be treated separately from the mathematical object considered (Gardiers, 1978). Related to Descartes’ conception of the development of mathematical thought that springs from intuition, symbolic writing, in his view, always keeps the intuition of the elements of calculation in mind and serves to foster broader intuitions. Mathematical writing, Descartes tells us, permits us to represent and visualize a certain mathematical idea; it allows us to fix certain ideas on paper so that we may remember them, thus enabling us to talk about or handle them better; it also enables the mathematician to order these ideas and to keep track of a reasoning in a succinct fashion. These important functions of symbolism in mathematical activity, like tools of conceptualization, processing, and communication, are well illustrated above.

Leibniz went further, however, by declaring himself opposed to Descartes’ position, and by giving priority to the symbolic treatment. Thus, for Leibniz, the function associated with symbolic writing “not only helps the reasoning, it replaces it. In fact, it dispenses the mind from ‘thinking’ the concepts it handles, by substituting calculation for reasoning, the sign for the thing signified” (Couturat, 1961). The word/sign serves here to access ideas, and the organization of the words/signs constitutes and precedes the organization of the ideas.³ This shows clearly how closely intermingled are the signifier/signified relations involved in the development of mathematics.

Changes in the status of symbolism over time revealed by this analysis refer (as is clear from the above) to certain epistemological standpoints. Thus the debate between the two above-mentioned positions regarding the use of symbolism, clearly launched in Descartes’ and Leibnitz’s day, will turn up again in 19th-century England. Pycior (1984), in his text, takes a look at this conflicting transition in the use of symbolism. In the denial of certain symbols

and their use in mathematics, the analysis reveals a tacit and empiricist philosophical base that is still present today in teaching and the use made of certain external representations. As for the use of symbolism, the empiricist positions will lead to denial of new mathematical entities such as negative or complex numbers, bearing no relation to the real world. Pycior retraces the paradigmatic evolution experienced at that period between an empiricist conception of knowledge and a nominalist conception (also present in our teaching of algebra, for example), in which the meaning does not help to guarantee the soundness of the reasoning, but where certainty rests on a system of logical deduction based on formal rules (marking the birth of symbolic calculation).

This analysis thus reveals certain conceptions of the nature of mathematics with which relations between signified and signifiers in the development of mathematics are closely linked. It also reveals within these broader beliefs legitimizing their use the essential role symbolism played in the development of mathematical thought. It reveals the constructed and dynamic character of this symbolic writing that appears as a process that supports a developing mathematical activity, or preceding it, the creator of new concepts and ideas, an indispensable tool in the formulation of this activity for purposes of treatment and communication to others.

Consequences for Teaching

The above analyses clearly reveal the complexity of the signifier/signified relations involved in the construction of knowledge. Mathematics is seen here as a constantly changing human and social construction where symbolism plays an essential role. It participates in the development and conceptualization of new mathematical objects, being part of the mathematizing or knowledge construction process, thus constituting an important tool of thought. In this perspective, symbolic representations are no longer seen as a reproduction of a certain external "reality," the significance associated with it up to the 18th century and still today, but refers rather to a construction of the subject that participates in this production. This viewpoint of the possible contribution of symbolic representations developed by children in the construction of mathematical knowledge inspired our several years of research with children (see Dufour-Janvier & Bednarz, 1989; Bednarz, 1992), which we now reexamine.

Elaboration of didactic interventions that take account of the symbolic representations developed by children and are articulated around them. We refer below to two classroom studies. The first research project (see Bednarz et al., 1992) on which the analysis is mainly based took place in a regular Island of Montreal grade 1 class (22 children aged 6-7), and primarily concerned construction by the children of concepts of number and operations. The second study to which we occasionally refer was conducted with the same group of children over a three-year period (from grades 1 to 3, aged 6-7 to 8-9) and introduced classroom learning of arithmetic based on the symbolic representations elaborated by the children themselves (Bednarz, 1992; Bednarz & Dufour-Janvier, 1985; Bednarz & Janvier, 1984b; Dufour-Janvier & Bednarz, 1989).

Starting in both cases with the children's productions, consisting of procedures developed to handle collections and symbolic representations perfected to take account of the collections and the operations done on these, the didactic

intervention establishes a social structuring of the class, leaving room for confrontations of various types in which the students can express their different points of view. The teaching is essentially viewed here as a social phenomenon in which interactions between the children (and between children and teacher) take place and give rise to an interpretation of the messages produced by both and to a certain negotiation process. Our research was inspired here by the theories proposed by the socioconstructivist school (Doise, Mugny, & Perret-Clermont, 1975; Mugny, 1985; Perret-Clermont, 1979) and more particularly by the didactic situations theory developed by Brousseau (1986).

Foundations of the Approach

The contribution of didactic situations theory appears highly pertinent for the purposes of a new relationship to symbolism on the part of students. Social interactions, which take the more specific form here of communication and validation situations, are at the heart of the classroom learning process. We briefly describe the dialectics involved.

The intervention is articulated around a set of problem situations where the child is asked to work out various solutions and make use of certain implicit models that will guide his actions. These models, referring to a certain implicit mental representation by the child of the relations between the data and to certain locally operating knowledge, assume their full meaning in relation to these situations and the actions of the subjects on them. The learning process will then be articulated around these solving methods and on this local knowledge constructed by the subject.

In communication situations involving a dialectic of the formulation between two subjects or two groups of subjects, the child will be led to construct a description, an explicit model of the situation and of the actions produced on the latter. The social situation of communication is used here to trigger a certain external representation process (this is one of the important functions of symbolic writing as a communication tool, identified above). The situation thus created is not restricted, however, to this communication role, but is destined to play an extremely important role in the knowledge construction process. Indeed, because the knowledge often takes the form of implicit models, this formulation dialectic will help to make explicit the different models used by the children. Thus the external representations developed have a twofold function: communication to others and conceptualization. They describe a developing mathematical activity. In these communication situations, explicit models will emerge and will then be able to produce differences of opinions among students that will be expressed through a debate (dialectic of validation).

Doing mathematics does not merely consist in imparting or receiving information in mathematical language, or even in understanding it. The child mathematician must now take a critical attitude towards the models he has constructed. (Brousseau, 1972, "p. 64)

This dialectic of formulation, and the strongly interrelated dialectic of validation, will prioritize the children's social interactions. Indeed, during the latter, as we see below, the child must explain to the other children the rules, sym-

bols, and conventions that he or she uses and explain and justify his or her choices, thus developing a certain reflexive competence not only about the content, but also about the symbolism that will be eventually adopted by the class.

The activities created within the context of the research that we now describe stem from these theoretical foundations.

Method

Because the research project on which the analysis (made in grade 1) is based focuses on the processes by which children create mathematical signification in specific situations, most of our research was conducted in the tradition of qualitative research (Erickson, 1985). The classroom sessions were videotaped on a regular basis throughout the project (September to January), two cameras permitting us to focus on several children during their participation. These recordings, with notes taken in the classroom and copies of all the children's work, form the source of the data that is used in the microanalyses of the children's in situ mathematical learning and their classroom interactions. Interviews were also conducted at different times of the year (August, November, and February) with each child in the group, thus enabling us to trace the evolution that had occurred in the children's conceptual development.

We now examine some of these data in relation to the more specific object of this article through information collected during several sessions (October 23 to November 13). This microanalysis reveals the role played by the symbolic writing developed by the children in the approach adopted.

Elaboration of Symbolic Representations by the Children to Handle Addition Problems

The situations described in Table 1 were introduced to grade 1 children (aged 6-7) at the very start of the teaching of addition and subtraction operations, within a sequence⁴ designed (a) to develop a certain signification related to the latter, and (b) to elaborate a symbolism that was meaningful to the children.

Toward the Need Felt by the Children for a Symbolization Process

The following contexts—a school bus carrying children or a city bus carrying passengers—with which the children were familiar were the basis of different, more or less complex, addition problems introduced over several sessions.⁵ The latter (see Table 1) were simulated by the teacher at the time of their presentation and verbalized simultaneously. It should be noted that the material used for this simulation, a Fisher Price bus and little figures, ensured that during the simulation the children never saw the passengers present in the bus as the actions occurred and therefore had to make a genuine reconstruction of the successive post-transformation stages.

Once the simulation was completed the children, individually or in twos, set out to solve the problem. A collective review of the solutions led to the formulation of various problem solving procedures (see Table 2).

Solving more complex problems (see situation 4, Table 1) required the children to introduce points of reference enabling them to keep track of the story as it unfolded (the information seemed harder to memorize here than in previous cases where the children could remember the story quite easily).

Table 1
Some Examples of Addition Problems Presented in Grade 1

<i>Problems based on the bus situation</i>	<i>Characterization of the problem</i>
Situation 1: the school bus leaves the garage in the morning and follows a certain route to the school. At the 1st stop 3 children get in. The bus restarts and continues on its way. At the 2nd stop 2 children get in. The bus has not yet finished collecting all the children who come to the school. At the 3rd stop 4 children get in. How many children are there in the bus after this stop?	Sequence of additive transformations
Situation 2: The day is over. The children have spent the day at school and go home in the evening. 9 children leave the school in the bus. At the 1st stop 2 children get off. At the 2nd stop 3 children get off. Are there any children left in the bus to get off? How many?	Sequence of negative transformations/an initial state is given
Situation 3: 10 children leave the school in the bus. After the 1st stop there are 7 children still remaining in the bus. What happened at the 1st stop? Did any children get in or off, and how many?	Reconstruction of a transformation, in this case negative
Situation 4: The city bus carries passengers. In the bus are 12 people when it leaves the metro station. At the 1st stop 2 people get off and 3 new people get in. The bus continues on its way. At the following stop 2 people get off. The bus continues on its way. At the 3rd stop 3 people who are waiting for the bus get in and 1 person gets off. The bus continues on its way. At the 4th stop 4 people get off the bus. The bus again continues on its way. At the following stop 2 people get in. How many people are there now in the bus?	Complex sequence of mixed transformations

We then saw children trying spontaneously to find ways to keep track of the story during its simulation in order to be able to reply to the question later: fingers raised or lowered to represent the number of passengers getting in or out, scribbles on paper, organization of the data (sticks or little figures added or crossed out), and an effort at counting as the story proceeded. Others gave up when faced with the impossible task, for them, of memorizing all the information. This was when they started to feel the need for writing to enable them to keep track of what was happening. This need would prompt the introduction of didactic situations to get the children to invent a process of symbolic representation.

Introduction of a Formulation Dialectic

In the communication situations different children in turn were asked to play the role of writer. They were entrusted with the task of keeping track of the story being simulated so that the other children could easily remember it and solve the problem proposed to them. To enable the children to see the need for an explanation of the language then introduced, recourse was had to strangers unaware of the proposed situation. Thus some children in turn left the classroom during the simulation and were asked to play this stranger role. They had to discover the story simulated from clues the writer had left them. In this

Table 2
Procedures Invented by the Children to Solve the Preceding Problems

Problems	Different procedures/verbatim comments	Characterization
Situation 1	"I counted on my table 1,2,3,...4,5,...6,7,8,9 stopping at each stop so I wouldn't be muddled"	support of the counting starting with 1, counting controlled to take account of the situation (addition at each stop)
	"Well, at the 1st stop, you put 3 kids in the bus, at the 2nd stop 2, that makes 5. Then, after the 3rd stop, you put in 4... So I counted 5,6,7,8,9"	global* recognition of the number 5 (like 3 and 2) then counting from this intermediate result 5
	"3,2 that makes 5. Then with 4 that makes 9" (shows with her fingers)	global* recognition of small numbers: 5 (like 3 and 2) and 9 (like 5 and 4)
Situation 2	"there were 9 then you took away 2. You took away 1 so that makes 8, then you took away another, that makes 7. Then you took 3, 7,6,5,4 so then I saw that there were really 4"	support of the backward counting starting with 9 (majority procedure)
	"Well, I counted how many you'd taken away, 5 then after I did 9,8,7,6,5,4."	first combines the 2 transformation, then uses the support of backward counting
	"you took away 2, then after you took away 3, so that made 5 in all ... then I knew there were 9 ... 5 + 4 that makes 9. Then you took away 5 in all, so that left 4."	she too takes the result of the 2 transformations / the global recognition of the number 9 (like 5 and 4) enables her to find the desired complement (additive reconstruction procedure)

* This aspect was explored with the children in the previous sequence on numbers: to develop a mental image of the numbers less than 10 (with the support of fingers or drawn configurations).

collective dynamic the other children played an active witness role because, having seen the simulation of the story and the writer's efforts to give an account of it, they could intervene critically in the ensuing debate.

In the first communication situation, the teacher simulated a statement that she verbalized simultaneously (Type I situation, Table 1, involving the successive addition transformation $+4,+3$ and $+2$). Behind a screen (thus she did not see the simulated situation, and the other children in the class did not see what she was writing), our writer (in this case Alexandra) had to find a way to keep track of the simulated story so that it could then be told and an answer given to the question. Once the process was completed the screen was removed and the stranger (in this case Ariane), who had neither seen nor heard the situation presented, was allowed back and was then asked to deduce the story from what had been written.

The message that Alexandra had left for us, and which constituted the first writing produced within the context of these addition problems, was: 4 3 2.

Ariane tried to deduce the story from this obviously incomplete writing: "Well, there were 4 in the bus ... then after 3 ... then after 2."

A discussion then started among the children⁶ criticizing the notation used in the light of its decoding by the stranger and the comments made by the other children who were present.

Emmanuel, concerning the imprecise nature of the figures "Alexandra just wrote figures ... so when Ariane looks at them ... what are they... she doesn't know."

Guillaume went further, explaining in what way this notation was not precise enough "Well, she doesn't know whether the kids are getting in or out..." (the actions were not indicated).

Eve Marie, thinking along the same lines, tried to find a chronology in the notation: "'Cause Ariane can't know if it began by 2 or by 4" (the beginning of the story was not indicated).

These collective debates, which were repeated on several occasions (different children were asked to play the writer and stranger roles), led the children to explain the codes and conventions used, to justify their choices and adopt a critical attitude toward them.

Evolution of the Representations Produced: a Process of Negotiation

The choice and acceptance by the children of various symbolic codes that took account of a situation and the relationships involved was not, as we now see, as immediate as might generally be thought. It was quite a different matter from a mere translation, a mere copy, at the symbolic level of the actions performed.⁷ In this case the writing was a construction of the subject that sought to take account of a certain "reality." The collective debates between children would play an essential role in this construction. We illustrate this in the following analysis based on a body of data taken from several sessions.

When the previous context was repeated at a subsequent session (Type 1 situation involving the successive addition transformations +2, +5, +3), the writer (in this case Benjamin) first produced the notation shown in Figure 1

In this notation, Benjamin, taking note of several of the arguments put forward in the previous discussion, adopted a code enabling him to indicate where the story began ($\rightarrow$) and another graphic code ($\uparrow$) indicating the transformations that took place (children getting into the bus). Further details not even mentioned in the discussion were then added such as the indication of the stops (system of reference points giving a chronology of the events). However, these were hard to differentiate from the figures that indicated the number of people getting into the bus. Benjamin also gave us (circled figures)

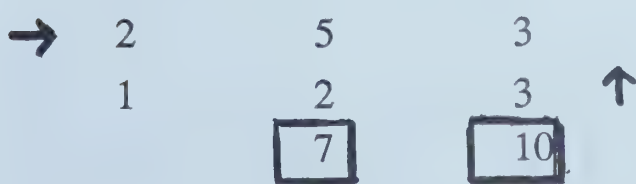


Figure 1.

the intermediate results (number of children after the 2nd stop) and the final result (number of children in the bus after the three stops).

These complex codes and conventions were not all decoded by the stranger (in this case Dominique) who deduced the following story from them: "At the first stop, there are 2 kids" [he showed the arrow pointing to the right when asked why he mentioned that to start with]. "They're getting into the bus" [he showed the arrow pointing upwards]. "Then after that there are? [he hesitated] who've got in? ... who've got in." Dominique's problems in decoding the different figures prompted Benjamin to explain the other codes and conventions he had used.

These suggestions, however, were not necessarily adopted by the other children in subsequent turns. Thus the next writer (Arnaud) wrote: 8 2 4 2 (for a type 2 situation involving the negative successive transformations -2, -4, -2, the bus initially carrying eight children). In this symbolization process Arnaud adopted a position that, as we see above, was abandoned by others (that consisting in only indicating figures).

The discussions then focused on the divergent positions expressed earlier by the children toward this type of notation: "Hey, it's just figures ... Perhaps Mathieu [they referred to the stranger] will think they going to get in" [the children's spontaneous reaction on the removal of the screen], which actually happened when Mathieu came back and told the story. "There are 8 kids who've got in, then there are 2, after that there are 4, and at the 4th stop there are 2." Once again different arguments were invoked:

"Mathieu can't know if they're getting in or out ... He hasn't put an arrow" [here the child referred in his reasoning to the codes that had been previously developed] and went on, "if the arrow points upwards, that means they're getting in, he knows right away that they're getting in" [the writer then spontaneously added a downward arrow to his notation].

Another child went on: "the 8, he's put a ring round the 8 ... 'cause that's where it begins," to which a counterargument was brought: "He had to put a ring round it at another place ... because Mathieu doesn't know whether it's the kids that are getting in or who are in the bus" [this child was trying to distinguish both states and transformations, and also referred in his reasoning to the code that had been previously adopted to that effect].

Returning to the attack and arguing along the same lines, a child repeated a little later: "The story that was told, there were 3 stops ... but you'd think there were 4 ... Mathieu thought that went with the story." Finally, another child explained, "In the end, you'd say it doesn't finish ... he's just marked the 3 figures... that's all" [she wanted to see the results indicated, as Benjamin had done previously].

In this real interaction between children,⁸ prompted when necessary by the teacher's questions, the production of a notation produced discussions between the students: The children clearly took a critical position toward the notations constructed, and were led to adopt or reject certain conventions and to compare one with another. The explanations and refutations required by this research were likely to contribute through the discussion process initiated to the emergence and development of new notations. Thus the following situation (featuring the following successive mixed transformation: +4,-2,-2

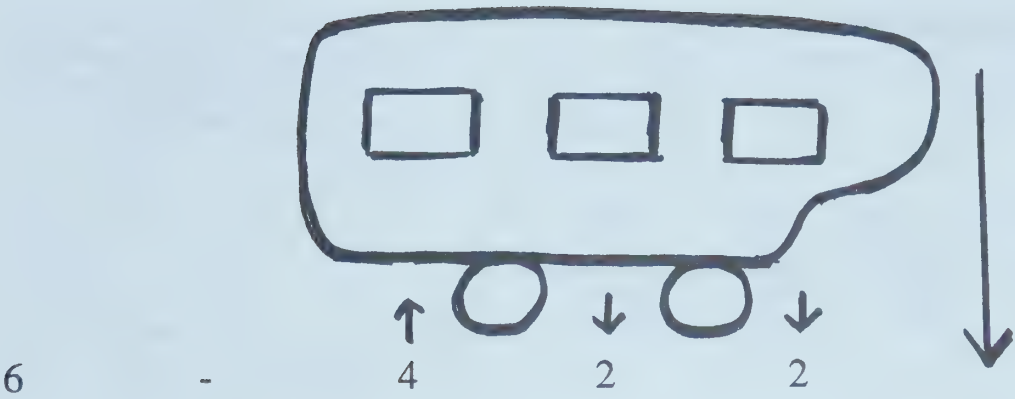


Figure 2.

with 6 passengers to start with in the bus) resulted in the elaboration of a new notation where the context was more strongly present.

What do These Symbolic Representations Developed by the Children Reveal to Us?
In leaving the children free to express themselves (recourse to language, drawings, symbols, etc.), we make possible the elaboration of tools that give account of a developing mathematical activity. The symbolic representations developed by the children in the framework of these addition problems, the way they understand them in order to handle these situations, express *the state of their knowledge* at a given moment of learning.

Thus, in this complex situation (see type 4 situation, Table 1, involving the successive transformations $+3, +2, -1, -2$ with 5 passengers to start with in the bus), where all the children this time were asked to play the writer role, various notations were developed. What does this previously unsuspected variety of possible representations by the children reveal to us?

Some children write down only the data, the numbers to which the story refers, without reference to the transformations with which they are associated (7 children). Here we find the type of notation previously developed by Alexandra and Arnaud, and still present at this stage in certain children, for example, $5 - 3 - 2 - 1 - 2$. This notation reveals strong concentration by the children on the states, the number being associated here with measuring size rather than counting the transformations (Bednarz & Dufour-Janvier, 1991).

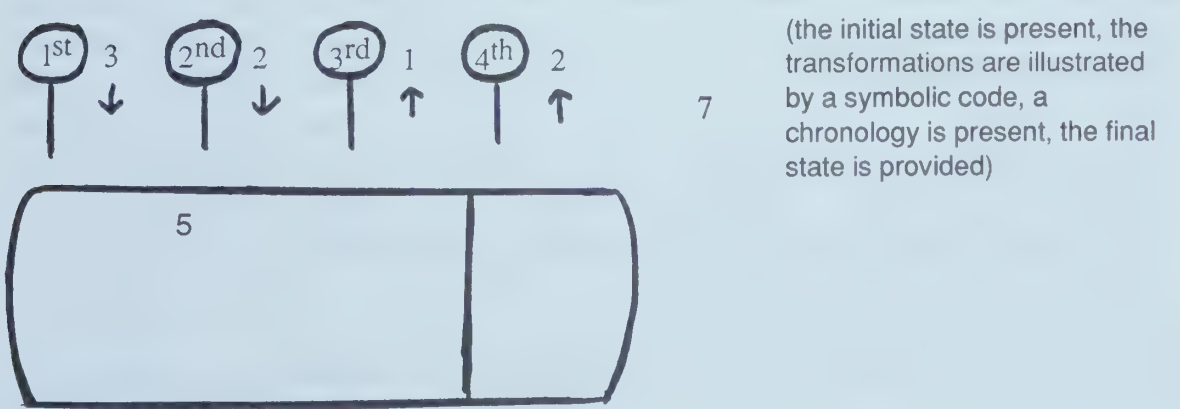


Figure 3.

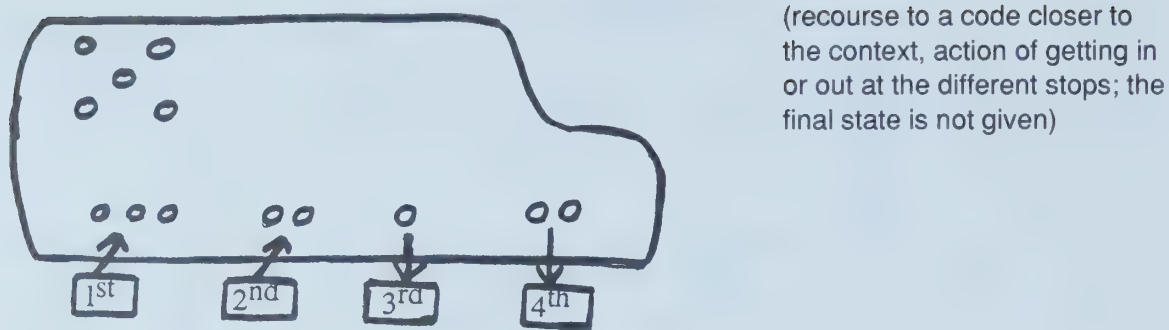


Figure 4.

Other children seek to record the initial state and the different transformations (9 children) making use of certain graphic codes (pictorial illustration with children drawn backward or forward, or symbolic codes $\uparrow \downarrow$ referring to the action of getting in or out of the bus). These symbolic representations, more or less well organized, try rather in certain cases to establish a chronology (start of the story, identification of reference points). These more or less abstract notations on the part of some children also refer to the context and the result.

Examples of notations belonging to this category are shown in Figures 3, 4, and 5. These notations that permit the story to be more or less accurately reconstructed do not necessarily enable the child to produce the answer quickly (the divergent replies to the problem posed show the difficulties that certain children experience in handling this notation that is meaningless to them).

Other children will try to account for both the transformations and the successive intermediate states, so that both the story and the result can be deduced more or less clearly from their message (5 children). Examples are shown in Figures 6 and 7.

One child illustrates only the successive intermediate states so that he can solve the problem, of course, but has difficulty in deducing the story that has led to this answer.

The need for the child to become more efficient in the handling of these addition problems, and in the communication of information about them, will lead to a refinement of these representations. Thus the children will gradually adopt a means of illustrating both the successive transformations and the intermediate states needed for solving the problem. Some children who then have recourse to a more symbolic code will return to a more descriptive code if they have difficulty in handling the problem. They will gradually be led seriously to consider a method of symbolic representation to express the problem and then apply it in situ. A similar process will be repeated in other contexts.

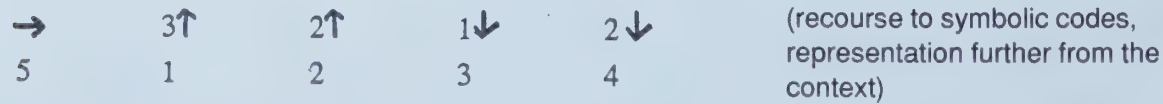


Figure 5.

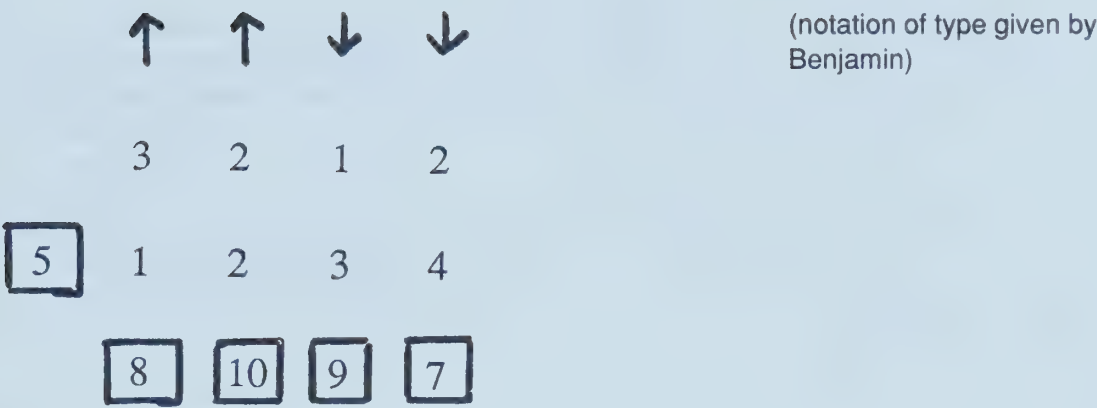


Figure 6.

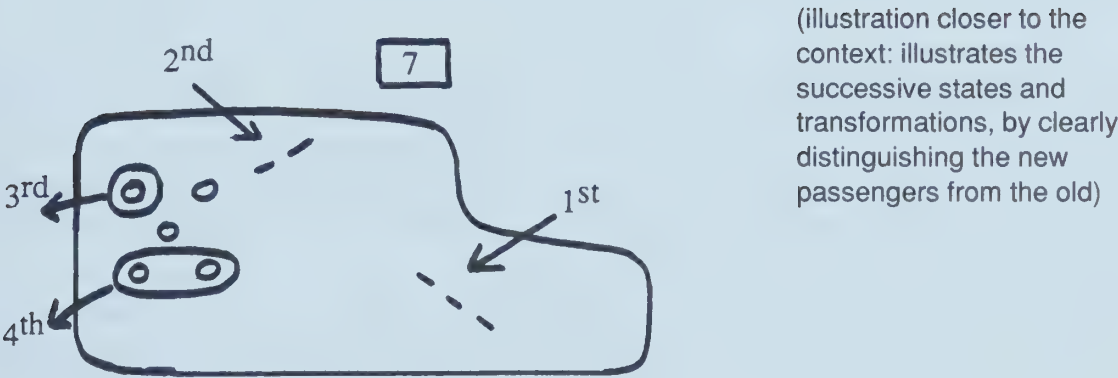


Figure 7.

A Better Informed and More Reflexive Relationship to Symbolism

In this procedure that we have briefly illustrated, symbolic writing constitutes an important tool for communicating with others and for conceptualization with regard to the child’s first arithmetical learning. In the underlying socio-constructivist perspective a new relationship to mathematical knowledge, affecting both signifieds and signifiers, is then introduced. By allowing the children to be critical and reflexive about the notations produced the focus is no longer on knowledge and a predefined symbolism but on a developing mathematical activity whose symbolism as a process constitutes one of the essential supports. This development leads necessarily to a questioning of organized knowledge. Thus, in the longitudinal research conducted by Bednarz and Janvier (see Bednarz, 1992), the children gradually adopted the notation shown in Figure 8 to deal with division.

This notation and the underlying calculation procedure gradually constructed by the children and accepted by all at the end of this process (social consensus) is just as effective as our standard algorithm. Subsequently faced with this procedure they were thus able to judge it with a critical eye, evaluating each contribution and then understanding regarding their own equally valid notation (moreover, the one for which they will continue to opt), the conventional character of this writing.

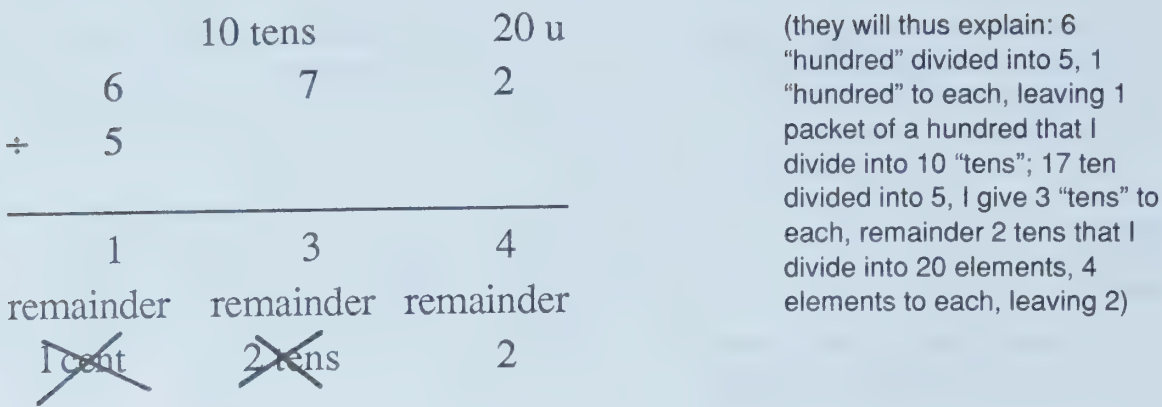


Figure 8.

Conclusion

The possibilities revealed by these studies appear important. They underline the close relationship between the symbolic representation activity and the knowledge construction process, and in so doing repeat the role that symbolic writing has played in the development of mathematical thought as a tool of communication and conceptualization.

As the actors of this construction, the children are better able to understand the pertinence of recourse to symbolic writing and to judge the relative value of one notation compared with another, thus acquiring a certain reflexive competence with regard to the symbolizations that they will subsequently have to face. The writing no longer seems detached from the mathematical activity but closely interrelated with it. The symbolization process thus assumes its full meaning with respect to a developing activity and the communication to others of certain ideas and problem solving procedures. The choices made and the evolution of the notations developed throughout the process appear to be functions of the social dynamics emerging in the classroom.

Notes

1. The analysis to which we refer is based on a current research program conducted by a team from CIRADE and funded by the Fond FCAR (Québec), concerning the conditions for the construction of algebraic reasonings and representations with regard to situations that have permitted, or permit, their emergence.
2. Thus, according to Viète, the objective is to develop a method that can enable any problem to be solved.
3. The creation of complex numbers and relative numbers in mathematics will fit into this new paradigm.
4. It should be noted that previously (September-October) the learning activities had concentrated more on the development of the concept of numbers. The children had been involved in the solving of problems leaving room for various possible strategies and organizations related to the tasks of the numbering, comparison, and ordering of collections.
5. These activities were interrupted by other learning activities.
6. On the basis of questions of the type: "Does she tell our story properly? What's wrong?" "Why is it hard for her to tell it?"
7. Many agree with this viewpoint, as we see at the beginning of this article.
8. The children's comments are adjusted to each other.

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"The Map is the Territory!" The Viewpoints of Biology Students on the Theory of Evolution

Although the spontaneous ideas of primary, secondary, and college students have constituted a favorite subject for science education researchers, those of adult students have been less popular. However, they are no less important, especially when it is a question of the next generation of scientists, as is the case with the graduate biology students with whom this study was conducted. Indeed, they are the eventual experts to whom certain authorities will turn to support their projects. So what representations do these advanced students entertain with regard to a theory that occupies a central place in their disciplinary field, namely, the theory of evolution? In order to answer this question we undertook a study of the representations of the theory of evolution of 15 biology students at the master's degree level. Through individual interviews, in particular, we focused on their conceptions of the evolutionary process and its components. Although a certain heterogeneity can be noted in the viewpoints collected, the latter tend to espouse a deterministic perspective of that process based on the belief in the equivalence of "map and territory."

Si les conceptions spontanées des étudiants du primaire, du secondaire et du collégial ont constitué un objet de choix pour les chercheurs en didactique des sciences, celles des étudiants adultes ont connu une vogue plus restreinte. Toutefois elles ne sont pas moins importantes, surtout lorsqu'il s'agit de la relève scientifique—comme c'est le cas ici— soit des étudiants de 2^e cycle en biologie auprès desquels cette étude a été conduite. Il s'agit en effet des experts éventuels auxquels certaines instances recourront pour appuyer leurs projets. Or, quelles représentations ces étudiants avancés entretiennent-ils à l'égard d'une théorie qui occupe une place centrale dans leur champ disciplinaire, à savoir la théorie de l'évolution? C'est dans le but de répondre à cette question que nous avons entrepris l'étude des représentations de la théorie de l'évolution auprès de 15 étudiants en biologie de 2^e cycle. Par l'intermédiaire d'entrevues individuelles notamment, nous nous sommes ainsi intéressés à leurs conceptions du processus évolutif et de ses composantes. Bien que l'on puisse

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noter une certaine hétérogénéité au sein des points de vue recueillis, ceux-ci tendent à s'inscrire dans une perspective déterministe dudit processus et à reposer sur la croyance en l'équivalence de "la carte et du territoire."

For a number of years our research, inspired by a constructivist perspective of science education, has enabled us to identify a set of didactic problems related to the epistemological aspects of the processes of the dissemination and appropriation of scientific knowledge. Indeed, although contemporary epistemology proclaims the inevitably constructed and social nature of scientific knowledge, the research we have either conducted or supervised reveals the persistence in the academic context of an idea of science and its associated concepts that is wholly dictated by facts. This idea holds that science is not divorced from sensation, the objects of its study are similar to the concrete objects of the usual reality, or else found ready made in a nature imbued with an immanent order through activities that can be likened to a ritual. Scientific concepts would have the same substantive character, reflecting the intrinsic property of matter (the magnet is made to attract iron) or testifying to what is at work in nature ([natural] selection will force reptiles to live more and more in trees). The research we describe here illustrates this latter aspect.

The Initial Concerns of the Study

The line between the biological and the psychological and social is often lightly crossed by scientists of all disciplines. Researchers' interest in education with respect to so-called gifted students, for instance, has been justified more than once by invoking, without the usual precautions, genetic and hereditary grounds. Similarly, certain scientists have proposed an interpretation of social behaviors such as xenophobia and aggressiveness that is based on biological models, especially the neo-Darwinian model of evolution (Sahlins, 1980). The promotion of these forms of reductionist biologism is a matter of concern to any educator aware of the misadventures of eugenics and sociobiology, especially because such reductionism occurs in a recurrent and marked manner, as one of us noted in the discourse of supposedly enthusiastic biology students. We become even more concerned at the thought that it might well be the teaching of biology that in some way prepares the fertile soil where such ideologies can flower. But what do students think when questioned directly on the subject? What do they know about the theory of evolution? Is the form of reasoning that underlies their discourse due to poverty of language or to ignorance of the implications of that theory? Is their reasoning inherited or is it consciously espoused? These are some of the concerns and questions that served to initiate our research.¹ The exploration of these questions showed that we needed to take a critical look at the theory of evolution and to conduct a concrete study on a group of biology students. Let us first examine some of the critical aspects of the theory in question.

The Semantic Pitfalls

As several studies on the subject suggest (Ruffié, 1982; Sahlins, 1980), the theory initially proposed by Darwin, like all theories, bore the imprint of the sociohistorical circumstances of the time. Indeed, the concepts of selection and survival of the fittest are not far removed from the ideas of free trade and elitism, for example, then prevalent in British society.² Nevertheless, this in no

way prevented this new paradigm from being highly fruitful as far as scientific research was concerned. Biological evolution is today as solid a fact as that of the rotation of the earth around its axis. However, this does not mean that the theory of evolution is conclusive and limpid, its epistemological status and its explanatory value still proving problematic even in its neo-Darwinian version.

Behind the confusion concerning the ins and outs of the theory of evolution lies a certain interpretation of the concepts of adaptation and selection. Adaptation, according to von Glasersfeld (1989), does not constitute an evolutionary type of activity, but rather the state of an organism or a species that from an observer's perspective has the necessary skills to ensure its survival in a given environment. Thus an organism can be said to be adapted to its environment because it survives. However, perhaps the use of the word as a verb introduces the widely accepted, though mistaken, idea of evolutionary activity: Because the word is often used as a verb (e.g., this or that species has adapted to such and such an environment), the impression has been given that adaptation is an evolutionary activity (von Glasersfeld, 1989, p. 125).

The same semantic shift also marks the use of the concept of selection and leads many people to think that evolution is omnipresent, even omnipotent, as if there were a mechanism in nature that according to certain criteria sorts out the organisms and selects the fittest. Yet it is only with hindsight that we can see that the sole organisms to survive are those that have certain characteristics enabling them to adjust to the constraints of the environment. In other words, the concept of selection as a directed and planned movement at work in evolution is of the same order as that of an invisible hand at work in the economy.

These apparently harmless semantic shifts have perverse effects, however, insofar as they can lead to acceptance of the idea of a determinism, or even fatalism, from the evolutionary and genetic point of viewpoint. As we see, it is one of the conceptual shortcomings of neo-Darwinian theory.

Chance and Self-organization

Among the shortcomings or, if preferred, the aporiae of the theory of evolution, the case of polymorphism corresponding to the heterogeneity of natural populations is especially eloquent. The latter cannot be explained by the neo-Darwinian model, because, according to Darwin, a population that maintains itself is mainly composed of homozygous individuals, natural selection gradually replacing the least fit genes by the fittest. To integrate the constraint of genetic polymorphism into the neo-Darwinian model, biologists like Dobzhansky (1977) have invoked new hypotheses, including that of the superiority of the heterozygote. However, in spite of these modifications, the model remained precarious and proved even more inadequate when an enzymatic polymorphism was discovered. It was hard to see the adaptive value of a variability in the structure of proteins playing the same role in different individuals of the same species. This proved a major stumbling block, and to overcome it certain evolutionist biologists came to consider that many of the forms of polymorphism neither increase nor reduce the individual's chances of survival: they are probably neutral and fixed quite randomly in space. Kimura (1983) thus stresses that it is senseless to ask, for instance, what the

advantages are from the evolutionary point of view of the proteins that characterize the various blood groups A,B,O, and so forth.

Thus the very idea of a natural selection mechanism directing the evolutionary process is challenged. In their quest for intelligibility, a number of biologists will invoke other concepts, such as those of self-organization, complexity, and recursiveness, to formulate what some describe as a new paradigm. Indeed, following the studies of Atlan (1972), Foerster (Segal, 1990), Prigogine and Stengers (1988), it is recognized that complex and open systems transform random perturbations into a new organization factor: the *order from noise* principle. Moreover, the principle of invariance, without which no form of genetic determination can be imagined, is probably complementary to it according to Atlan (1972), in that it would ensure memorizing of certain stages of the self-organization mechanisms. This is the case, for example, of the genetic program in which the DNA molecules permit invariance insofar as they participate in a recursive organization: to be read and executed, the message associated with the DNA molecules requires the very products of its reading and execution. In the wake of these ideas, the claim that the stages of evolution can be rigorously reconstituted and the future predicted loses its pertinence: the deterministic argument no longer holds good, a probabilistic type of reasoning must take its place (Jacquard, 1986).

We thus witness the emergence of a new representation of evolution that simultaneously integrates both randomness and invariance into the evolutionary process (Blanc, 1982; Brooks, 1983; Gould, 1980; Levy & Cohen, 1984). And it is by virtue of this approach that we can propose, following Harper (1977), certain conditions that must be met in order to predict the direction of a population's evolution:

If, in a population (e.g., a population of rabbits living in a barren environment, in the presence of a predator who hunts at sight),

1. we observe a hereditary phenotypical variation (black rabbits and white rabbits);
2. we observe a differential reproduction (the young black rabbits are more numerous than the young white rabbits);
3. we see that, in this differential reproduction, there seems to be a selective advantage for a given variant (the black rabbits are less exposed to predation);
4. we observe that there seems to be no correlation with a characteristic that confers a greater contrary selective advantage (the black color characteristic does not correlate, for instance, with a characteristic of sensitivity to a parasite that can cause the death of a large number of black rabbits before they attain sexual maturity);

Then, the population is likely to evolve as assumed by the use of the concept of natural selection, that is, in the present case, toward a population composed mainly of black rabbits.

A study of these conditions clearly shows that the theory of evolution is not deterministic in nature. Indeed, the third condition indicates that for a given setting it is impossible to know exactly what the dominant selective pressure is. Moreover, the fourth condition, by introducing the concept of correlation, highlights the probabilistic nature of the theory and shows quite clearly that

we cannot predict how environmental pressures, which act at the phenotype level, may in the long run modify the genotype (because of the various possible correlations). In addition, this fourth condition reveals the complexity of the organism by showing that it is not a gene nor a locus that evolves, but an organism whose whole set of genes interacts to form a phenotype that is subject to environmental pressures.

As noted in our opening comments, biology students seem to know little about this new pluralistic representation of the evolutionary process, or at least rarely mention it in their discourse. But what do they think of this theory when they are questioned explicitly on the subject? What interpretations do they invoke to explain the evolution of a given population? Do they mention the conditions that we have presented above? What role do they attribute to chance? Do their viewpoints reveal a critical reflection on the conditions mentioned above and on the ideological changes the theory of evolution may undergo? In short, what representations³ do these student biology buffs entertain with regard to the theory of evolution and its explanatory power? Before examining the data collected on this subject, let us briefly recall the guidelines for their collection and analysis.

Methodological Elements

Our study was conducted with 15 university students enrolled in a biology master's program and having taken at least one course on the theory of evolution. Because the objective of our study concerns the nature of their representations with regard to that theory, we chose the semistructured interview as our main tool for data collection. This type of instrument not only facilitates access to the representation as product, but also to the representation in the process of self-organization, that is, the concerns or interpretations formulated during the interview. In order to evaluate the coherence of the students' viewpoints, we also made some marginal use of two other data collection instruments: a simulation and a questionnaire.⁴ However, we present here only the material collected during the interview, which constituted our principal data collection instrument.

The interview protocol (see Appendix) was designed to permit the students first to express their viewpoints on the conditions required for there to be evolution of a population in the sense postulated by the concept of natural selection. We asked them to reconstitute four evolutionary situations, that is, the evolution of reptiles; the emergence of a population of insecticide-resistant dipterous insects (mosquitoes); the industrial melanism of a population of lepidopterous insects (butterflies); and the evolution of an imaginary population of lagomorph mammals (black rabbits and white rabbits) in specific environmental conditions. The second part of the interview, which includes more abstract questions, was designed to enable us to examine how the students conceptualized the notion of natural selection, the relationship between genotype and phenotype, the role of chance and, lastly, the object of the theory of evolution itself.

To give an account of the viewpoints conveyed from the comments collected, yet not confining ourselves to this first level of signification, we chose a two-level qualitative *analyse du discours* (Maingueneau, 1976). Although our aim at the first level was to list the objects mentioned in these comments, that

is, what the students talked about, we were primarily interested in identifying the representation that gave these objects their importance and meaning. In other words, we were interested in the ordering of these objects, the intensity of their presence (for example, the relative importance attributed to each of the conditions listed above); the cores of meaning that these objects helped produce or from which they proceeded, the reconstitution of which would enable us eventually to characterize the underlying representation. Moreover, two other aspects also had to be considered during the deconstructing and reconstructing the students' comments. First, the comments were *solicited* because we had delimited the proposed field of study. Second, they often took the form of an *argument*. Indeed, especially regarding the questions on the evolutionary situations, the students were likely to explain and justify their viewpoints, in short, to defend the viability of their predictions on the basis of certain givens.

In the circumstances, given the diversity of both the theoretical and technical constraints of our data collection, we worked out an analytical device that combined elements borrowed from different content analysis models. Our approach was inspired by Vignaux's model (1976) for identifying propositions of discourse based on groupings defined by the objects of the comments according to their relationships of involvement, the oppositions and analogies contained by these propositions, and the redundancy of these various components (Bardin, 1984). Similarly, with the help of Toulmin's model (1976), we paid special attention to the qualifiers that the students might mention in their arguments, that is, the conditions for supporting or refuting their conclusions. Finally, apart from revealing the specific internal coherence of each comment, we were also concerned with a possible horizontal coherence, by the application of cores of meaning from one comment to another in order to reach a certain saturation of meanings for the whole body of data. So what were the representations brought to light by means of these various operations? Following are some indicative cases (Tremblay, 1968) that convey the dynamics of all the material collected.

Results and Discussion

As indicated, the first four questions of the interview invited the students to propose a reconstitution of four evolutionary situations. According to all the students questioned, the evolution of these populations seemed to be due entirely to natural selection, as illustrated by the following extract:

I think that certain Reptiles invaded niches that were vacant for predatory purposes and then, afterwards, on the basis of the model of reptilian birds like the Archeopteryx, there was evolution and selection of the characteristics of birds to hover longer. There were primitive birds that possibly hovered to catch their prey and there was evolution of the characteristics to favor hovering and then, eventually, that gave them characteristics to favor hovering. (S5)

But what conditions were required for evolution of these populations to take place in the direction that from the students' point of view would correspond with that indicated by natural selection? Table 1 shows the frequency of mention for each of the four conditions listed above.

Table 1
Frequency of Mentions of Each of the Conditions by Subject

	<i>Reptiles</i>		<i>Mosquitoes</i>			<i>Butterflies</i>			<i>Rabbits</i>		
S1	C1	C3	C1	C2	C3	C1	C2	C3	C2	C3	C4
S2			C1	C2					C1		
S3	C1		C1	C2	C3	C1		C3			
S4	C1		C1			C1				C3	
S5	C1	C2	C1					C3	C2		
S6	C1	C2	C1						C2	C3	
S7	C1		C1		C3	C1		C3	C1		C3
S8	C1		C1			C1			C1		
S9	C1			C2	C3	C1	C2	C3			
S10			C1	C2	C3	C1	C2	C3		C3	C4
S11			C1	C2	C3						C4
S12	C1	C3	C1	C2	C3				C1		
S13	C1	C3	C1	C2		C1		C3		C3	C4
S14		C3	C1	C2	C3			C3			C4
S15		C3									

In general, this table shows that no one seems to take account of the four conditions simultaneously, and this applies to all four evolutionary situations considered. Moreover, when a subject mentions one of these conditions, he or she does not always take it into account in all four situations. Thus only two subjects (S7 and S8) consider the first condition (C1) in all four situations; no one seems to take account of the second condition in the whole set of situations; one subject (S1) mentions the third condition in each situation and no one mentions the necessity of the fourth condition in all the situations.

Moreover, according to the situation in question, we also note a marked difference in the frequency of mention of the conditions. The greatest number of conditions (essentially C1, C2, and C3) were recorded for the evolutionary situation of the mosquitoes (30). A fair number of conditions (19 and 17) were recorded for the butterflies and reptiles respectively, while for the rabbit population a smaller number was noted (13). Is it conceivable that reference to the first three conditions depends on the students' degree of familiarity with the evolutionary situation in question (from case histories cited in biology text books), or on its short time span? Although we cannot answer this question, we do point out that as soon as the question is of a less familiar evolutionary situation (such as the rabbit case), the number of conditions mentioned drops. It seems that the subjects were hardly aware that the evolution of a population in the direction apparently indicated by natural selection assumes that a certain number of conditions be met, and that this direction is always solely one possible direction among others.

Table 1 also shows that the fourth condition attesting to the probabilistic character of evolutionary theory is mentioned only nine times. The following

extracts, one concerning the reptiles case, the other that of the mosquitoes, illustrate this consideration:

But I tell you, it could have been hair, the animals could have remained bare, have a different circulatory system, it's one of the possibilities ... among several solutions, that that's the one that adapted was just due to chance (S13)

It's possible that that characteristic was related to other behaviors; the set of genes that you've selected is linked to other behaviors or other properties of the individual ... There are cases that you can select for a characteristic that wouldn't be advantageous because it will be offset by other things. (S14)

When one considers the issues of the present debate on evolutionary theory, it is remarkable that only a third of the students (five) mentioned this essential condition at least once when one considers the issues of the present debate on evolutionary theory.

The data collected in reply to questions 5 and 8 may be broken down according to the weight attributed to natural selection and the relationship between a characteristic and an adaptation. The whole set of data may be regrouped under the title epistemological status accorded to natural selection, whereby if it is considered that all characteristics correspond to an adaptation and are the result of natural selection, this implies, in a way, attributing omnipotence and omnipresence to them. The comments concerning these aspects follow the same lines as the comments gathered during the first questions of the interview, namely, that the evolution of populations seems to be caused by natural selection alone. Twelve of the 15 subjects thus explicitly consider natural selection as omnipresent and omnipotent (The best proof that it's natural selection acting on animals to give us the forms we know today is perhaps the study of fossils [S1]), whereas the comments of three other subjects (S5, S12, S15) tacitly convey the same idea:

I think it's due to the different conditions, different exposures to the light. I think they're adaptations to the quantity of sunlight. This coloring has evolved and then the white skin in the northern regions, the periods of snow mean ... that there's been a gradual adaptation to the different environments. (S5)

For these students, the factor of chance thus hardly seems to intervene in the evolutionary process. In their view, that process is strictly determined by natural selection, an attitude not too far removed from the foundations of traditional deterministic reasoning. But how do the students view the effect of environmental pressures on the phenotype? Do they see the genotype/phenotype relationship as being linear or, on the contrary, as fitting into a recursive organization?

The comments relating to questions 6 and 7, which deal respectively with the level of organization on which natural selection supposedly operates and with the object of the theory of evolution, are instructive in this regard. Generally speaking, the students maintain that natural selection sometimes acts on the genes (For Dawkins, it's at the level of the genes [S3]; It acts on the genes, [S11]), sometimes on the phenotype: It acts on the phenotype. The phenotype it's what you find on the animal, what shape it'll have, what type of fur ... so the environmental pressure will operate on the phenotype [S12]).

However, according to Jacquard (1986), natural selection acts neither on the phenotype nor on the genotype, but on an individual that corresponds to the outcome of many interactions between the various genes and the surrounding environment. Certainly over the generations there may be an impact on the proportions of the genes, but to maintain that the action of natural selection impacts on the phenotype or the genotype suggests that the relationship between them is simple and direct.

Moreover, the discussion concerning the object of the theory of evolution reveals the students' lack of awareness about the current controversies surrounding it, although their comments constitute a concrete illustration of these debates. Indeed, while some of the students believe that the theory of evolution should study intergenerational changes in genetic structures, others consider that it should focus on individuals' performances in relation to their environment. The following extracts illustrate these two tendencies.

The theory of evolution could tell us that for one population or another to develop or maintain its fitness there's a natural selection where forces within a population will maximize its survival during the environmental changes that occur. (S7)

The theory of evolution tries to explain the variations of populations that occur over time and to relate them to the ecological pressures that those populations have probably undergone. It tries to explain the emergence of new species. (S9)

But, as Jacquard (1986) recalls, phenotypes are not transmitted; only genes are transmitted. In this sense, to consider that the theory of evolution has genetic mechanisms as its object (S11) or that it explains ... [enables] us to understand how and why, in a given population, the gene frequencies will change at a given moment ... [and shows] the mechanisms that finally operate changes in the genetic frequencies in the populations (S13) is just as incomplete as to reduce this subject to the study of phenotypes in their relation to the environment. Moreover, if we have operational models of intergenerational gene transmission, the relations between a particular genotype and a particular phenotype always prove complex. To restrict the object of evolutionary theory to the study of correspondences between phenotypes and environments or of genetic transmissions amounts to an overoptimistic simplification of the genotype/phenotype relationship to say the least.

Table 2 summarizes the whole set of data obtained following the analysis of the corpus. It shows how the students' comments may be classified according to the conditions of the evolutionary process, the status accorded to natural selection, and the characteristic adaptation and genotype-phenotype relationships. Thus we note that the students (S13 and S14) who consider the fourth condition (with a frequency of two) in their reasoning also seem to consider that a characteristic may well not correspond to an adaptation and that the genotype/phenotype relationship is not simple. In other words, these students would also take account of the role played by chance in the evolutionary phenomenon. Other students (S10, S1), while mentioning the fourth condition, seem to consider, however, that natural selection is omnipotent and omnipresent and that all characteristics are adaptive (S10). Moreover, their viewpoints on the phenotype/genotype relationship vary between simplicity

Table 2
Summary of Interview Data

Frequency of C4		OMNPR/OMNPT	CC=A	GEN/PHEN
S1	1	OMNPR/OMNPT	0	C/S
S2	0	OMNPR/OMNPT	0	C/S
S3	0	OMNPR/OMNPT	0	S/O
S4	0	OMNPR/OMNPT	CC=A	C/S
S5	0	≠OMNPR/OMNPT	CC=A	C/S
S6	0	OMNPR/OMNPT	0	C/O
S7	0	OMNPR/OMNPT	CC=A	C/S
S8	0	OMNPR/OMNPT	CC=A	C/S
S9	0	OMNPR/OMNPT	CC=A	C/S
S10	2	OMNPR/OMNPT	CC=A	C/O
S11	1	OMNPR/OMNPT	CC≠A	S/S
S12	0	≠OMNPR/OMNPT	CC=A	C/S
S13	2	OMNPR/OMNPT	CC≠A	C/C
S14	3	OMNPR/OMNPT	CC≠A	C/S
S15	0	≠OMNPR/OMNPT	CC=A	O/C

S1, S2,...S15: student questioned
OMNPR: natural selection omnipresent
OMNPT: natural selection omnipotent
GEN/PHEN: relationship between genotype and phenotype
C4: fourth condition
C: the genotype/phenotype relationship is complex
0: no reply or non-pertinent reply
C/S: relationship considered sometimes simple, sometimes complex
S: the genotype/phenotype relationship is simple
CC: characteristic
A: adaptation

and complexity. Should this variance be seen as a sign of ambivalence in their reasoning? Does it represent hesitation between a deterministic reasoning and a probabilistic reasoning prompted by the degree of importance accorded to chance? In what cases do they seem inclined to reason deterministically? How can this hesitation be explained?

It should be noted that, in general, those who do not stress the necessity of the fourth condition seem to consider that natural selection is omnipresent and omnipotent, that all characteristics correspond to an adaptation, and that the genotype/phenotype relationship is simple. In short, if we come back to our research concerns, for most of the students we questioned the mechanism of natural selection seems to hold an almost ontological status that makes it an omnipresent and omnipotent mechanism in that it allows evolution to be rigorously predicted.

Conclusion

Although the data collected show a certain heterogeneity, they seem to stem most often from a form of reasoning that can be described as deterministic. Thus, given a specific population, only one evolutionary direction seems possible. Moreover, this would supposedly result exclusively from an om-

nipresent and omnipotent natural selection. All characteristics would correspond to a simple adaptation attributable to its advantageous aspect for the individual. As regards the relationship between the genotype and the phenotype, this would be simple and direct: given a particular phenotype, only one possible genotype would control it. Finally, natural selection would always enhance the population's adaptive potential. It should be noted, however, that certain subjects contradict themselves during their reasoning. Sometimes they take account of chance as a factor of the evolutionary process; sometimes they exclude it completely and then reason in a deterministic manner. What does this contradiction mean? Can it be interpreted as a sign of the presence of a cognitive imbalance induced by our questions?

In our view, during our experimentation, which lasted about three months, we perhaps placed the students in a situation that fostered such an imbalance, through the use, in particular, of data collection instruments that invited them to constantly clarify their representations. Moreover, these contradictions can also be seen as variations in their reasoning. Although they do not invalidate our general conclusion, namely, that most of the students questioned tended to use forms of deterministic reasoning and that several of them expressed agreement with statements with a sociobiological bias, as indicated by their answers to the questionnaire, they do oblige us to limit its reach. Indeed, it is impossible to establish a simple relationship of implication between a form of deterministic reasoning on the one hand, and adherence to sociobiological and eugenic theories on the other. But is it really surprising to observe such contradictions?

In a way it is no surprise, for the cognitive functioning of individuals, their thought, also shares the complexity that characterizes biological systems. It should be remembered that the functioning of thought involves—often implicitly—values, beliefs, epistemological and metaphysical theories, and intellectual habits that form the world view, the *reception system* that imbues all comprehension of an object of knowledge and all production concerning it. In this perspective, a person can easily produce deterministic-type reasoning without being fully aware of their ins and outs, while rejecting in the name of certain values or beliefs what for others is inherent in this reasoning, such as the introduction of eugenic measures. This is what we were able to observe on several occasions in the students' comments. Conversely, it may be thought that students express their agreement with statements that we consider to be sociobiologically or eugenically biased owing to inherent prejudices or beliefs that they have never had occasion to question (e.g., the belief in human nature), while using a probabilistic type of reasoning in their comprehension of the theory of evolution.

So how can we explain this propensity to propose deterministic-type explanations of evolutionary processes? Must we blame the teaching content? Does the teaching of the theory of evolution present the students with the various concepts of evolution and their implications? Does it take into account the fact that the deterministic and probabilistic concepts convey two different world views, the first tending toward a better type and homogeneity, the second taking account of diversity and the fact that any event is but *one* possibility among others?

In any case, the students we met seem to have little awareness of these questions. They seem well informed about neither the present debates surrounding the theory of evolution, nor about what differentiates the deterministic paradigm and its core concept of natural selection from the probabilistic paradigm based on notions of complexity, self-organization, and chance. Can it be thought that the students' deterministic reasoning is merely due to lack of information?

Even if this is a plausible explanation, it does not necessarily solve the whole the problem. Another aspect seems to us to lie in the constant confusion that the students make between the model and what it supposedly explains, as if the map were the actual territory. It is worrisome, to say the least, that these master's students in biology did not demonstrate a critical attitude toward the modeling character of all theory, including that of evolution, which is inevitably simple compared with the evolutionary process considered. But it appears as if the students—and here we invoke Wittgenstein (1965)—try to seek behind the substantive the substance and thus reify the mechanism of natural selection.

This type of representation may not be entirely unrelated to the atomized approach that usually characterizes science teaching (Larochelle & Désautels, 1992). The method, which consists in decomposing to better analyze, has resulted in enormous progress in biology and in science generally. Without vivisection, microscopic observation of cells would not have been possible. But once the analysis is completed, the cell must be replaced in the tissue to see how it functions. This action of putting the cell back into its tissue (then the tissue into the whole organ, which, once observed, must be replaced in the system, which must itself be replaced in the organism as a whole, etc.) demonstrates the complexity and thus leads to probabilistic reasoning. Numerous researchers (Atlan, 1986; Morin, 1985) are of this opinion and maintain that it is in the study of complexity and self-organization that biological evolution must seek its paradigm, self-organization necessarily being considered as "the foundation of both the organization of individual organisms and of the processes of evolution of the species" (Atlan, 1972), and invariance, although fundamental, necessarily being considered in second place. Is this a concept of the evolutionary process that we find in present-day teaching or, on the contrary, does this teaching convey only one concept of the process? Moreover, as teachers, are we concerned with helping students develop meta-view-points on the knowledge taught, to exercise constant epistemological vigilance that will enable them to understand that the map is not the territory? These are questions that we cannot afford to ignore.

Notes

1. This study was the subject of Zaim-Idrissi's doctoral dissertation (1987).
2. In spite of this similarity, the theory of evolution also seems to us to have been at odds with accepted ideas. Thus, in postulating that species derive one from the other and organisms descend from simpler organisms, it was opposed not only to the religious ideas of the day, but also from the scientific point of view to the vitalistic ideas that attributed intentionality to the evolutionary process.
3. The concept of representation that we borrow from the field of psychosociology refers to the knowledge, notions, and beliefs that a person holds in order to organize his or her conceptual experiences and give meaning to the events and information of his or her daily life. In this sense, according to Jodelet (1984), it can be viewed as an essentially dynamic

- “reception system” because it is not merely a juxtaposition of content components. Indeed, as is shown, for example, by Moscovici’s (1984) study concerning the processes whereby common sense makes scientific knowledge digestible, the representation that lies in the intellectual work as well as in the finished products this work strives to create.
4. In the field of science education, the subject that concerns us seems to have found little favor with researchers if we consider the small number of studies that take an interest in it and are usually carried out on high school students. Despite this limitation, the works listed reveal the varying importance accorded to the theory of evolution in education, even if the textbooks used to give fairly considerable space to it (Levin & Lindbeck, 1979), although, according to Skoog (1969) this has clearly decreased since the 1960s. Moreover, we note that the students tend to give a Lamarckian interpretation of evolution (Brumby, 1979; 1984; Deadman & Kelly, 1978), and to confuse the biological sciences and the physical sciences (Barnett, Brown, & Caton, 1983). Finally, 54% apparently believe in evolution rather than creationism, 24% do not believe in it at all, and 22% are skeptical (Grose & Simpson, 1982).
 5. A collective enterprise, the simulation process included several stages during which the students were asked to draw up a list of hereditary characteristics, to state the characteristics of the environment in which a population exists, and to imagine how the latter would evolve after 100 generations. The questionnaire was designed so as to identify the subjects’ position with regard to sociobiological or eugenic reasoning and to biological determinism in general. The various questions were inspired by the studies of authors who either reasoned in this way or, on the contrary, criticized this approach. Thus we formulated five questions such as: Comment on the statement “Differences in intelligence level (IQ) are genetic in nature in a proportion varying between 70% and 80%.”

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Appendix

- Q.1 Explain the stages that have marked the evolution of reptiles. State the conditions that had to be met for their evolution to take this direction.
- Q.2 In 1978, the WHO (World Health Organization) announced a new outbreak of malaria that affected more than two hundred million people. This is said to be mainly due to the resistance of carrier mosquitoes to the insecticides used. How could this have happened? What conditions had to be met to permit the emergence of a mosquito population resistant to the common insecticides?
- Q.3 Let us consider a population of *biston betularia* living in the area of Liverpool, England. This butterfly alights on white-colored lichens that cover tree trunks. Before industrialization, these butterflies were mostly creamy white in colour. Some black bistons were found, but they were few in number. How did this population evolve after industrialization? What conditions had to be met for it to evolve in this sense?
- Q.4 In a population of black rabbits and white rabbits in a barren environment, there is a predator that hunts at sight. How would this population evolve after a dozen generations? What conditions must be met for this population to evolve in this way?
- Q.5 On what facts can we base support for recognition of the action of natural selection in the history of animals? Give an example.
- Q.6 At what level does natural selection operate?
- Q.7 In your viewpoint, what is the object of evolutionary theory?
- Q.8 If we assume that *homo sapiens* appeared in Africa, how can we explain the fact that different skin colors in humans exist today throughout the world?

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Learning to Think: Philosophical Instruction and Reflective Educational Practice

This article gives an overview of the work of a research team interested in the philosophical training of primary and secondary-level students as well as that of the teaching personnel. The team first examined the problem of moral education in the school (institutional aspects, foundations, educational approaches) and then turned to experimentation of a Philosophy for Children program (Lipman, Sharp, & Oscanyan, 1980). Through its educational approach, this program offers a pertinent means of helping students to learn to think and provides an interesting framework as regards the development of a reflective educational practice on the part of the teaching personnel. This article shows how European and American influences as well as practical and theoretical considerations can be combined in research studies pursued in Québec.

Le présent article donne un aperçu des travaux d'une équipe de recherche qui s'intéresse à la formation philosophique des jeunes du primaire et du secondaire, de même qu'à la formation du personnel enseignant. L'équipe s'est d'abord intéressée à la problématique de l'éducation morale en milieu scolaire (aspects institutionnels, fondements, approches éducatives) pour ensuite se concentrer sur l'expérimentation d'un programme de philosophie pour enfants (Lipman, Sharp, et Oscanyan, 1980). Ce programme offre, par son approche éducative, une voie pertinente pour aider les élèves à apprendre à penser et fournit un cadre intéressant dans une perspective de développement d'une pratique éducative réflexive chez le personnel enseignant. Cet article permet d'illustrer comment les influences européennes et américaines ainsi que les dimensions théoriques et pratiques peuvent se conjuguer dans les travaux de recherche poursuivis au Québec.

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Some 15 years ago, the Ministry of Education invited its partners in the teaching sector to relaunch educational reform in Québec (Ministère de l'Éducation, 1977). This was an invitation to undertake general reflection, primarily destined to give fresh impetus to concerns of a pedagogical nature: educational values, study programs, pedagogical assessment, and staff enhancement.

The years have gone by and major changes have been made in the pedagogical systems, study programs, and evaluation policies, but the cries of alarm concerning the whole educational system are still just as numerous and increasingly insistent. Regarding the students, several shortcomings are deplored: the poverty of their mother tongue, the gaps in their scientific training, their difficulty in organizing thought, their absence of general culture, their loss of social sense, and the rise of intolerance and violence. Regarding the teachers, there is talk of burnout and accusations of lack of support with respect to the new educational challenges. Many people, including ourselves, think that the school has neglected, if not forgotten, an essential element of its mission: teaching to think. In our view, learning to think is an integral part of children's basic instruction; moreover, it has constituted a central theme in the reflection on education in Quebec over the last few years (Conseil supérieur de l'éducation, 1984; Gohier, 1990). Learning to think, from the point of view of basic instruction, means promoting openness of mind in the learner, exercising critical reflection, and starting a process of integrating the various fragments of knowledge. Nor can this be dissociated from an experience of community life that fosters a sense of cooperation and positive recognition of differences through dialogue.

From this standpoint, our team, which is attached to the Centre interdisciplinaire sur l'apprentissage et le développement en éducation (CIRADE), has been pursuing a research program for over 10 years, in particular in the field of moral and philosophical education. In our investigation we have been anxious to maintain a fruitful dialogue between theory and practice and to explore procedures that really serve education in the schools. The purpose of this article is give an overview of our work and to indicate some of its major issues. Our initial concerns regarding moral education have made us aware of the importance of children learning to think for themselves in order to be able to exercise their critical faculty and form moral judgments based on reasoned criteria. The first part retraces how we came to this awareness by combining theoretical perspectives, basic research on the moral development of the child, and classroom interventions. This phase of our work led us to focus on the philosophical training of children and to undertake research in collaboration with teachers in order to develop a constructivist inspired reflective educational practice. In the second part, we present Lipman's Philosophy for Children program (Lipman, Sharp, & Oscanyan, 1980) and describe the avenues we have explored in the philosophical training of students. The third section presents our current investigations regarding the training of teachers in reflective educational practice and indicate various options for future inquiry.

Moral Education: Learning to Think for Oneself

To speak of moral education in Quebec leads to numerous debates on a variety of issues. Although it is inappropriate here to give an historical overview of

the situation, we must at least recall that the development of moral teaching in Quebec has been compromised by the vestiges of a confessional debate that has not yet been settled despite a succession of structural reforms (Caron, Dupuy-Walker, Quesnel-Maheu, & Schleifer, 1984; Lebuis, 1986). Our inquiry is set against a complex background that has led us to familiarize ourselves with the institutional context of moral teaching in the schools, to question the foundations of moral education, and to explore various approaches that conciliate theoretical considerations and practical propositions.

Interest in the moral and social development of the individual led the investigators in the initial core of our team to focus on the cognitivist perspectives, especially on Piaget's studies. Rejecting a behaviorist approach to moral training, according to which adequate instruction should produce specific behavior, this interest in Piaget's works revealed the importance of reasoning in the development of moral judgment and in the exercise of autonomy at the behavioral level (Schleifer, 1977). From this standpoint, we focused on different aspects of moral life to see how these became structured in individuals during their development: judgment of intention, social decentration, notions of falsehood, justice, friendship, and so forth. These studies, inspired by Piaget, provided highly pertinent tools for measuring from specific angles the moral development of children in the framework of our classroom experiment. Indeed, conscious of the issues of a nonindoctrinating type of moral instruction (Schleifer, 1976), our team wished to examine the contribution of educational approaches that, by the distinction they make between the form and content of moral education, propose to develop children's moral thinking rather than make them assimilate specific contents as was envisaged by the traditional style of moral education. These studies focused on Lawrence Kohlberg's cognitive and developmental approach, John Wilson's perspectives of rational utilitarianism (Oxford, UK) and on the values clarification movement (Harmin, Simon, Raths, and Kirschenbaum).

Analysis of the different data available, including both quantitative data generated by tests and qualitative data provided by the observations of the teachers involved, while not indicating an approach superior to others with respect to moral development, did reveal different factors that contribute to the quality of the learning acquired within the framework of a specific moral teaching: the quality of the teachers' intervention, their experience, their training, and pedagogical support; the students' motivation; the pedagogical support constituted by specific learning procedures and recourse to a particular approach; adaptation of the pedagogical material to the children's age. In particular, these experiments revealed the possibilities that children can develop when their reasoning and decentration abilities are called on (Caron, Lebuis, Schleifer, Dupuy-Walker, & Brunel, 1987). These studies have convinced us that any educational approach in the moral field must allow reflection, and for this purpose must take positive account of the contribution of diversified points of view in order not only to refine personal judgment, but also to create awareness of the necessary complementarity of viewpoints. Anxious to avoid any form of dogmatism and indoctrination, we then set out to implant an educational approach that would permit the development of thinking skills while encouraging an experience of interactive peer dialogue.

In the Philosophy for Children program, which we discuss below, we found an interesting process.

Concurrently with our experiments with different approaches to moral education, we pursued a theoretical reflection on the nature and object of moral education. These studies led us to examine the writings of Peters (1966, 1972, 1974) and Reboul (1971, 1977, 1980), urging us, among other things, to envisage the question of the foundations of moral education less from the viewpoint of primary basic principles than from that of aims to be pursued. These theoretical studies by philosophers of education confirmed what we had discovered in practice concerning the need for an educational approach based on the learning of personal thought and the experience of a meaningful social life. In this respect, Reboul's reflections on indoctrination and on the ultimate goals of education proved especially inspiring.

Reboul (1971) is primarily concerned with the philosophy of culture and education. His works contain no study devoted exclusively to moral education, but the question of moral education always accompanies his reflections for "moral education is really nothing else than education itself" (p. 101).

A humanist, concerned above all with respect for personal freedom and access to a culture of the universal, Reboul refuses to see moral education as an opportunity to inculcate a particular moral code. He considers it, rather, as an awakening to different attitudes and values in order to learn to think for oneself, while respecting persons and facts. Because "to educate means giving to each the power to judge lucidly one's own attitudes and to be responsible for them" (Reboul, 1984, p. 145), "moral education, precisely because it is the very core of all education, can only be self-education" (Reboul, 1971, p. 119). Such a conception does not exclude the possibility of teaching. It might even be said that Reboul's work basically consists in identifying what true teaching must be in terms of the goal he ascribes to education:

The goal of true education, whatever its content may be, is to form adults: persons capable of assuming their responsibilities and keeping to their commitments, thinking for themselves, respecting the facts even when they contradict them. Any teaching that turns aside from this goal seems to me to be counter-teaching. (Reboul, 1977, p. 7)

Against this background, it is easy to understand the important place occupied in Reboul's numerous works by his reflections on indoctrination and the purposes of education. In his view, "what distinguishes teaching from indoctrination is not that the latter is untruthful, but that it prevents the student from seeking and learning by himself, because it represses thought" (Reboul, 1984, p. 158).

In asking how teaching can become indoctrination, he notes that it is not the intention, nor the content, nor the method that defines an indoctrinating type of teaching, but rather the very goal of the intervention. There is indoctrination as soon as teaching shifts away from its true goal: the emergence of personal thought, that is, "the power to examine, understand and judge" (Reboul, 1977, p. 102). In this respect, if we admit that teaching always implies the intention to "make someone learn," it must be remembered that "to make someone learn may mean to make him know, act, understand; it can never mean to make someone believe" (Reboul, 1980, p. 117), and that "true teaching

goes nowhere without the development of a critical mind, in other words, without the risk that our students end up by thinking differently from ourselves" (Reboul, 1984, p. 158).

Reboul's reflections constitute an invitation to a salutary exercise in lucidity: first, to acknowledge that it is an illusion to believe in neutrality but also, and above all, that it is possible to teach with due concern to offer situations where it is the student himself who exercises judgment. For such situations to be educational, they must constitute opportunities for the student to find a meaning to life and to relate his present experience to his whole existence and to the experience of those around him. For Reboul, "the only remedy against indoctrination lies in an education which, in full respect of individuals' freedom and thought, meets their need for community, truth, meaning" (Reboul, 1977, p. 197). In our view, the Philosophy for Children program offers a pertinent framework for putting such a conception of education into practice. Indeed, while Reboul provides us with essential perspectives on the matter of education, Lipman offers us a concrete approach that enables us to implement a philosophy of education based on the learning of personal thought. This Philosophy for Children program seemed to us a promising testing ground where moral education is an integral part of children's basic instruction by offering a context for learning to think within an ethical community of inquiry.

Learning to Think and Philosophy for Children

The Philosophy for Children program, developed by Lipman and various collaborators at the Institute for the Advancement of Philosophy for Children, fits into the present trends in educational concerns respecting the development of thinking skills and a critical mind. The basic goal of the program is to help children think for themselves so that they can "discover the rudiments of their own philosophy of life" and "develop a more secure sense of their own identities" (Lipman, Sharp, & Oscanyan, 1980, p. 80). Lipman, who has been greatly influenced in this respect by Dewey, makes a distinction between *thinking* and *thinking well* and believes that it is the school's role to encourage children to think better, that is, more reflectively. Because it is through dialogue that a person's reflective skills can be improved, if the class is organized along the lines of an interactive community, each student will be empowered "to think reasonably, to develop patterns of constructive action, become aware of personal feelings and the feelings of others, develop sensitivity to interpersonal contexts, and acquire a sense of proportion regarding his or her own needs and aspirations vis-à-vis those of others" (Lipman et al., 1980, p. 171). When children practice reasoning together, they become more capable of reasoning and more attentive to the complementarity of points of view.

The Philosophy for Children program proposes that we adopt an organic model where the approach is global and focused on the concerns of the students themselves rather than on a technical model based on the transmission of knowledge according to a mechanistic and atomized approach. Philosophy can then be seen as an activity that is practiced and that enables each student to become aware of his or her thought and to see himself or herself as a thinking subject. Philosophical teaching is thus similar to a process of collec-

tive elucidation of the children's questions. For this purpose, the Philosophy program offers special support in the form of novels designed for primary and secondary-level students and user guides for teachers.

At present the Program proposes seven novels and corresponding guides:

- *Elfie and Getting Our Thoughts Together*: The exploration of individual and collective experience (knowledge of self and the other); reflection on the emergence of thought.
- *Kio and Gus and Wondering at the World*: The discovery of the world: a reflection on nature and introduction to scientific thought.
- *Pixie and Looking for Meaning*: The discovery of sense: reflection on language.
- *Harry Stottlemeier's Discovery and Philosophical Inquiry*: Philosophical inquiry: logical reasoning, critical thought and investigative skills.
- *Lisa and Ethical Inquiry*: Ethical inquiry, moral reasoning.
- *Suki and Writing: How and Why*: The aesthetic experience, reflection on art, poetry, and language.
- *Mark and Social Inquiry*: The social experience: reflection on social problems.

Each novel tells a story in which children experience situations that lead them to reflect in an autonomous and critical manner and to ask themselves questions of a philosophical nature: What is a habit? What's the difference between a cause and an effect? What's an excuse compared with a good reason? What's thinking? Do animals think? What's the difference between what's real and what's apparent? When can you say something is true? How do we know what's around us? How can a blind person discover the world around him or her? Why do people talk? Are we destined to do what we do or are we free? How can the requirements of society and the particular beliefs of a group be reconciled? If something's not bad for an adult, why should it be so for a child? What does being fair mean? Is there equality between people in spite of their differences of sex or color? These numerous questions are but a brief sample of the subjects for reflection proposed by the Philosophy for Children material. More important still are the questions that the students themselves succeed in formulating after reading the stories.

The basic methodology of the program is as follows: the children in groups read a chapter or episode of one of the novels; they then identify the themes, ideas, or questions that attract their attention; finally, they proceed to an in-depth discussion around specific aspects. The teacher's guide is intended to give pedagogical support: it suggests avenues to be explored (discussion plans, exercises, activities) that the teacher can use in the classroom to foster better understanding or to facilitate greater interaction between the children. Thus it is not a question of reaching predetermined objectives or of addressing content elements in a fixed order.

In Philosophy for Children it is the ideas retained by the students after reading the proposed story that constitute the content of the course. In this respect there is no absolute necessity to discuss the sample questions at any particular moment or in any particular sequence; they will come up for discussion provided a group of students agrees to make them an object of inquiry and reflection. The very formulation of the questions will vary in essence depending on the group's interests. The "raw material" suggested by the

students will be the object of special treatment or refining, within the framework of what might be called a *cooperative reasoning workshop*, for if a matter for reflection emerges from the interactions, a manner of reflecting together so as to enhance everyone's thinking skills will also emerge. The experience of a community of inquiry is synonymous with the learning of autonomous and critical thought.

Philosophical teaching as experienced according to the Philosophy for Children program approach encourages personal thought and offers the experience of a community reflective practice based on cooperation and dialogue: the student learns to think autonomously and coherently and to share his or her thoughts with others who have different ways of thinking. This requires the practice of a Socratic type of teaching that Johnson (1984) presents as follows:

Orchestrating a philosophical discussion involves returning to thought and points of view volunteered by students, weaving the threads together, and assisting students to understand that their ideas make a difference in their lives. Like Socrates, a teacher of philosophical inquiry must be a gadfly, admonishing students to be intellectual risk-takers, encouraging them to think for themselves, aiding them to discover underlying assumptions, and assisting them in the search for more comprehensive solutions. (p. 25)

Our studies in relation to this program conducted in a school setting led us to recognize in the lateral communication within the classroom—communication between students facilitated by the teacher—the mainspring of an authentic construction of knowledge, know-how, and behavior. This communication permits the circulation of infinite impressions, opinions, and knowledge related to the students' experience; these elements become the basic matter of a cooperative inquiry process, orchestrated by the teacher and carried on by the students themselves. Through free circulation of ideas an educational environment can be created where the diversity of points of view expressed by the students constitutes an initial reference from which meaningful knowledge can be structured. In this context the teacher's role is not to disseminate predetermined knowledge, but rather to let this emerge through means that invite the students to question themselves and to structure their thoughts. They thus learn to confront different points of view and understand the reasons that support a particular statement, while seeking to distinguish the criteria that justify the integration of new elements and the restructuring of their own references. The inquiry community spirit enables this learning to be done in a cooperative rather than a competitive climate; it is no longer a question of determining who has *the* right answer, but rather of working together to better understand the various aspects of a reality that question and challenge us.

Since the fall of 1985, we have concentrated our classroom experiments on the application of the Philosophy for Children program. Our first concerns were the links between moral and logical reasoning in children, and we therefore focused on the question of training and support for the teachers called on to use a philosophical approach in a moral instruction class. Analysis of the data collected between 1985 and 1989 revealed that the students in groups experimenting with the Philosophy for Children program had made

significant progress with respect to logical reasoning, especially with regard to transitive relations, inclusion problems, and syllogistic problems. Moreover, the teachers involved noted considerable progress in the fields of concept formation, language skills, and relational abilities (Daniel, Schleifer, Lebuis, & Caron, 1987; Lebuis, 1989; Schleifer, Lebuis, & Caron, 1987). The focus on the teachers' philosophical training also led to general considerations that go beyond mere familiarization with the material and the pedagogical approach of the Philosophy for Children program: the educational intervention in all disciplines can be envisaged as a reflective approach based on the practice of dialogue and the authentic construction of knowledge (Lebuis, 1987, 1989, 1990; Schleifer, Lebuis, Caron, & Daniel, 1990).

Toward a Reflective Educational Practice

The introduction of the Philosophy for Children program in primary and secondary classes constitutes an opportunity to question educational practice. Indeed, the teaching of philosophy to children and teenagers from the viewpoint of learning personal thought (learning to think autonomously and coherently, to share one's thoughts with others who can have different ways of thinking) requires an interactive style of teaching. The Philosophy for Children program proposes situations, ideas, and concepts that the students can examine systematically under the guidance of someone who can promote dialogue. Because it is a question of accompanying the students in their questioning about the situations that concern them, the essential function of the teacher consists in helping the students to reflect by proposing material for questioning and by stimulating them in their reflection process. This method, very different from the *laissez-faire* approach, requires that the teacher adopt a reflective form of intervention. Proponents of the Philosophy for Children program insist on this practice of reflection on the part of the teachers by requiring them to participate in communities of inquiry where the appropriation of the pedagogical material and the educational approach to the program is based on the direct experience of philosophical debate.

Lipman et al. have developed a special training model for teachers using the Philosophy for Children program. This model proposes that those interested in this program should have the opportunity to participate in reflective practice workshops where they can learn about philosophical reflection and become familiar with the program's educational approach. It is essentially a question of participating in a community of inquiry that experiments with a process of philosophical investigation, according to the specific methodology of the Philosophy for Children program (reading, gathering of ideas to be discussed, discussion, and exercises).

What this training model entails is to be able to practice philosophical discussion within a community of enquiry, not to receive information on how to go about conducting such an exchange. In Philosophy for Children, teacher training primarily depends on the experience of philosophical debate. Using the material destined for the classroom as a springboard for their own reflection, not only do the teachers familiarize themselves with this material but they also experience at their own level what participation in a community of enquiry can mean. In an ideal training perspective, it is desirable—if not essential, although classroom conditions do not always facilitate its applica-

tion—that this participation in a community of enquiry be completed with support to enable an instructor to coach the teacher in the field. This double experience may help to make the teacher aware of the conditions required to make philosophical discussion possible in a reflection-based interactive process.

The Philosophy for Children program proposes that we adopt an organic model where the approach is global and focused on the students' concerns. This approach is highly demanding from the standpoint of educational intervention because, as it is designed to foster the learning of philosophical reflection, it implies a pedagogical flexibility that requires the educational intervention to be guided by reflection so as to prevent it from being rigidly constrained to the servile application of a particular methodology. That is one of the challenges of teacher training, not only in Philosophy for Children, but in all academic disciplines, from the moment teachers are made responsible for the pedagogical act rather than as mere technicians of infallible methods.

In this regard, the writings of Schön (1983, 1987) on reflective practice seem to us to be extremely useful in helping us more clearly understand the various levels of a practice of reflection in an educational context.

Schön (1987) sees training in reflective practice as depending on the practice of reflection in action, by confronting learning-by-doing situations. To optimize this training, for ultimately everyone is his or her own instructor, Schön considers coaching as the key element. In addition to the exercise of reflection in action at the very heart of situations, the dialogue between the instructor and the teacher may take the form of reciprocal reflection in action. The presence of these different levels of reflection in action assumes the ability of the various partners to move up what Schön calls a ladder of reflection (pp. 114-117). This ladder of reflection comprises:

1. a practice;
2. the description of the practice;
3. the reflection on the description of the practice;
4. the reflection on this reflection.

To support the reflective practice of teachers is to work in the field of educational practice, by using and formalizing teachers' know-how and undertaking with them a joint reflective spiral experience that helps to enrich our respective fields of knowledge, skills, and attitudes.

Like all professional knowledge, the teacher's practical know-how is multifaceted. It cannot be reduced to an appropriation of a field of knowledge, although it comprises knowledge. It implies a know-how that allows the teacher to make the appropriate moves in given circumstances and, above all, an ability to judge (or appreciate) that helps to enrich the initial repertoire and plan the intervention.

For Carr and Kemmis (1986), this knowledge constitutes a springboard for critical reflection where relations between theory, as organized knowledge, and practice, as organized action, can be addressed from their problematic aspect for the purpose of a dialectical reconstruction. If organized knowledge in itself cannot be received as a definitive discourse capable of guiding the educational practice, neither can practice alone claim to take account of the

whole scope of the educational activity. It is at the meeting point of theory and practice that a renewed relation to knowledge can emerge.

Vanoye (Honoré & Bricon, 1981) notes that "present training leads to overestimating two aspects of teaching": knowledge and what he calls *pedagogism*, meaning a set of recipes enabling knowledge to be efficiently transmitted in a climate of maximum serenity. In his view, the emphasis must be shifted toward training that leaves room for "the analysis of what one does and what one is" (p. 29). In this perspective, we have been engaged since the fall of 1990 in a collaborative inquiry project in different academic contexts, postulating that involvement in an inquiry process is likely to constitute an ideal method for teachers to acquire training and continuing education, the impact of which concerns their professional development as much as improving pedagogical practice and the quality of academic life (Lebuis, 1991; Caron, 1991). Thus we join with an increasingly broad consensus that is emerging in teacher education: education can no longer be reduced to the updating of knowledge, the material taught, and the mastery of teaching techniques. Obviously, a critical mind and professional judgment must be developed. Once this is affirmed, concrete ways must be found of avoiding the snares of promoters of technical approaches to reflection, like that of Cruickshank (1987), in order to go beyond the model of technical rationality, as hoped by Schön, in favor of a constructivist perspective.

We believe that the Philosophy for Children program offers an appropriate framework for fostering the development of authentic reflective practice in the world of education. By fostering a critical appropriation of the educational approach in Philosophy for Children, we encourage collaboration where teachers, consultants, school principals, and university professors and investigators may together rethink education to make it a meaningful experience for children today. It is not a question of just talking about it: it is time to act.

In this sense, during the coming years we want to focus more on action research initiatives articulated around specific problems inspired by our present studies. So far, the partners have often focused their attention on the conditions and consequences of implanting the Philosophy for Children approach. Individual meetings with teachers, group meetings held in the different contexts, and evaluation sessions held at the university with all the individuals involved in our present projects reveal that the inquiry community experience in the classroom proves crucial with regard to many aspects of children's basic instruction. We intend to investigate some of these aspects within the framework of action research projects. The aspects chosen depend on the interest shown by our partners in the educational field. Thus we plan to address the question of the contribution of the inquiry community to the construction of students' knowledge; we shall pay particular attention to the development of language skills (mainstream classes at the primary level, adjustment classes at the primary level, special classes at the secondary level) and through the development of ethical competence (moral instruction classes at both levels). We shall also focus on the impact of the community of inquiry experience on interethnic tolerance (primary and secondary classes). The application of the action research process around these specific questions should

enrich the experience of the community of inquiry for the teacher and broaden the perspective of reflective educational practice.

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On Writing Teaching

At a time of constantly expressed concern regarding written language skills, literature offers writing that it would be very much in the interest of teaching to explore further. A problem of reading, structured around the key concepts of Barthes' textual analysis, permits establishment of a first diagrammatic representation of the movement of reading, a movement liberated by the dynamics of the text and the seminar. A problem of teaching completes the representation; this permits the identification of an original problem of both writing and teaching. Finally, a piece of a few pages gives a concrete illustration of teaching as it unfolds within the limits of writing.

À l'heure des inquiétudes toujours entretenues vis-à-vis de la compétence en langue écrite, la littérature offre des espaces d'écriture que l'enseignement aurait tout intérêt à fréquenter davantage. Une problématique de la lecture, structurée autour des concepts-clés de l'analyse textuelle de Barthes, permet d'établir une première représentation schématique du mouvement de la lecture; un mouvement libéré par la dynamique du texte et du séminaire. Une problématique de l'enseignement complète la représentation; elle permet d'identifier une problématique originale de l'écriture et de l'enseignement. Enfin, un morceau de quelques pages vient illustrer concrètement l'enseignement en train de se faire dans les limites de l'écriture.

At a time when lack of written language skills on the part of future teachers is being denounced, and when strategies and content for teaching writing are being questioned and reviewed, thus apparently a crucial time for the links between teaching and writing, yet the essential element concerning these links remains obscure. Almost nothing is said about the teaching of writing: to show teaching through writing as it unfolds.

There is a reality of writing about which the well-known theories on writing and teaching are usually silent, due to the very nature of the links fostered by the university between writing and teaching. In literature as in pedagogy, the links that dominate are indeed those of subordination: in literature, teaching must serve writing. For example, writing workshops usually focus on literary production. In contrast, in pedagogy writing is at the service of teaching. Activities of all kinds organized to promote written language skills are based on the ideal of communication that teaching rightly emphasizes. Here we have two concepts of writing: the writing itself as practiced and thought by modern literature, and the written word as practiced and defended by common sense. Literary theory and criticism of the last 30 years have clearly shown the difference between these two concepts; I return to this point below.

I mainly deal here with a third concept, that of the notation of teaching, a reflection on the writing of reading to be undertaken in the wake of the reading-writing, as practiced especially by Barthes (1979, 1984, 1985), and examine some of his concepts.

A Problem of Reading

In some so-called textual analyses, Barthes practices a reading filmed in slow motion. A partisan of modern literary work that transforms the reader-consumer into a reader-producer, Barthes reads-writes texts. And this is not merely rigor in the analysis. Any close reading of a text, whatever the method of analysis, constitutes a sort of slow motion reading and is not necessarily related to textual analysis. It is, rather, a step-by-step writing, from the tutor text, without privilege—but not without preference—for any meaning; a writing (re)constituting the plural existence of the text to be read. This is because the literary institution has long plunged the reader into “the poor freedom either to accept or reject the text: reading is nothing more than a *referendum*” (Barthes, 1970, p. 10). “What can be read but not written” (1970, p. 10), Barthes calls the *readerly* as opposed to the *writerly* that he defines as follows:

the writerly text is ourselves, before the infinite play of the world (the world as function) is traversed, intersected, stopped, plasticized by some singular system (Ideology, Genus, Criticism) which reduces the plurality of entrances, the opening of networks, the infinity of languages. The writerly is the novelistic without the novel, poetry without the poem, the essay without the dissertation, writing without style, production without product, structuration without structure. (1970, p. 11)

Opting for the plural thus means passing from the readerly to the writerly within the reading itself. It means liberating the readerly text of its supposed readability and enriching it with everything of which the divorce between reader and author—between consumer and producer—deprives it. Reading-writing is an important gain in meaning. To start with, the text is four or five times longer: marked with asterisks and cut up “into a series of brief, contiguous fragments which we call *lexias*, since they are units of reading” (Barthes, 1970, p. 20), it is then dissected, from *lexia* to *lexia*, by the systematic identification of the signifieds. Thus the play of the significations is revealed in slow motion and the way the different cultural codes, unknown to readability in general, play (with) the text. Here is an example taken from a reading of Balzac’s novel, *Sarrasine*.

(205) *And answered with two names: Zambinella! Jomelli!* * ACT. “Question”: 3: to receive an answer. ** The preceding proairetism (“Question”) has an overall connotative value; it serves to designate La Zambinella as a star; this signified has already been attached to the old man; it is linked to the international character of the Lanty family and is the source of their wealth (SEM. International star). *** Who is, or rather: what (sex) is La Zambinella? This is the text’s sixth enigma: here it is thematized, since its subject is emphatically introduced (HER. Enigma 6: thematization). (Barthes, 1970, p. 112)

The number in parentheses indicates the number of the *lexia* whose text follows immediately in bold italic print. The dissection is somewhat arbitrary, primarily a matter of convenience: at least a sentence, or part of a sentence, and

at most three or four sentences per *lexia*. The rest is commentary added by the reading-writing; it is constituted of meanings observed and classified according to an elementary notation system: the star marks a meaning; the number of stars, the rank assigned to it in the commentary; the abbreviations of three capital letters indicate the codes in play; Barthes proposes five such codes: hermeneutic (HER), semantic (SEM), symbolic (SYM), action (ACT), and reference (cultural) (REF). The code mark is usually followed by an argument and sometimes by a number, the rank of this argument in the reading. Barthes interprets *meaning* as “the *connotations* of the *lexia*, the second meanings” (1985, p. 331).

It should be added that such reading practice is not reconstitution of a first meaning of the text, but proliferation of the meaning. There is no last word to conclude the analysis. Such a commentary does not offer the same structural guarantees usually encountered in the dissertation or the *explication de texte*, whereby the tutor text is gathered into a coherent whole: its closure. Fragmented, the text draws its coherence and its truth—never assured—more from the play of omission (of a certain idea of self and of meaning) in the permanent gaps of the text, through which the meaning or even the truth never add up. This new operation is the interpretation of a text, but otherwise: “To interpret a text is not to give it a (more or less justified, more or less free) meaning, but on the contrary to appreciate what plural it constitutes” (Barthes, 1970, p. 11). And there is nothing liberal about it, “it is not a question of conceding some meanings, of magnanimously acknowledging that each one has its share of truth; it is a question, against all in-difference, of asserting the very existence of the plurality” (1970, p. 12).

The text concept finds its equivalent on the speech axis in the seminar concept. *S/Z* and many other works by Barthes emerged from research seminars in which graduate and postgraduate students participated. The seminar concept is in a way the reverse of the text concept. Indeed, the speaking/listening couple on which I propose to base it finds the readerly—let us here call it the *speakerly*—on the side of production (speaking pole), and the equivalent of the writerly—what I call by a play of etymology the *auscultatory*—on the side of consumption (listening pole). This is merely an effect. For the speakerly, like the readerly, primarily signifies the pitiless divorce between speaking and listening; and the auscultatory, like the writerly, signifies the plural existence of the seminar, the ceaseless exchange of words.

The speakerly exchange—the lesson well delivered, for example, in the seminar—demands only one thing: to be received in all its transparency; the wishing-to-say meets no serious obstacle in the saying. The listening is then passive; it receives the speakerly. The auscultatory exchange, on the other hand, calls for active listening, as practiced in psychoanalysis. The words heard then stem from a veritable logic of writing, the ideal mode of the unconscious. Recently, many works have been written at the crossroads of literature and psychoanalysis. Significant in this respect are the works of Jacques Lacan, for example. These are certainly seminar texts.

The seminar is thus the analogue of the text. The writerly and the auscultatory put an end to the double divorce between reading and writing and between speaking and listening.

The divorce is nonetheless maintained between speaking and writing. Barthes (1984) claims that writing begins as soon as speaking becomes impossible; in other words, the writerly and the auscultatory designate the writing pole of the continuum; and the readerly and the speakerly, the speaking pole. These two poles even refer to an implacable conflict between language and soul. Two extreme ways of practicing autobiography illustrate this clearly.

In the classical text, autobiography is the occasion for a subject to lay bare his or her soul; language is the means. It is talking about oneself, in a readerly text, in a confidential or confessional tone; speech dominates. In the so-called modern text, it is somewhat the opposite: I am called by the language to let it talk in its very plurality; I serve the language; I am its means. A reading of Leiris will provide convincing evidence of this. Here, the writing dominates.

Finally, Barthes' textual analysis, reading filmed in slow motion—the seminar-produced text—gathers together in the same place the reading, writing, and listening to the exclusion of speech—speech, of course, taken in the speakerly-writerly sense. This might be represented as shown in Figure 1.

The direction of the movement is important: from the reading one moves to the text passing through the listening, the writing and the seminar. In the following problem, the opposite direction is noted.

A Problem of Teaching

No one imagines that teaching takes place in a vacuum. It is always a question of teaching something. What is taught may never bear one's own signature; and when it does, this would never constitute more than a part of one's teaching. The university fosters a certain divorce between the production and the transmission of knowledge. And the efforts to give greater importance to

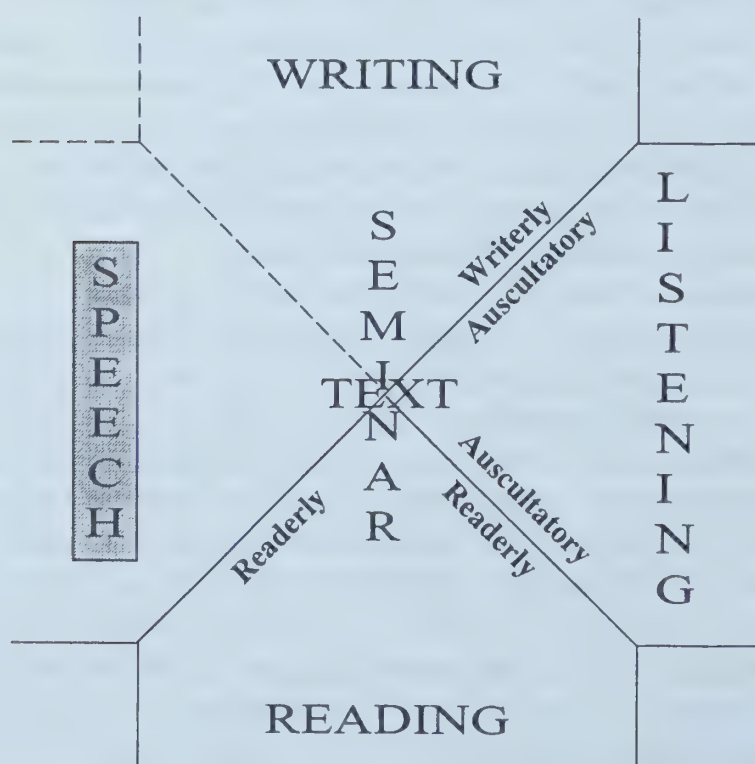


Figure 1.

teaching—a teaching more and more devalued compared with research—culminate in a qualitative equality between producing and transmitting, on exactly the same tone as the “in” slogans concerning equality in difference. Nonetheless, in the general economy of university-produced knowledge, the difference between teaching and research is one of nature (between equal values) and not of degree. Here the difference is just as marked—although it is not the same—as between reading and writing in the classical literary institution.

But surely it is possible to practice an analysis of teaching that is analagous to the type of textual analysis that Barthes favors in reading? I propose to think of the relation between teaching and research as a practice not of reading, but of writing filmed in slow motion; the production of the seminar from the text rather than the reverse: teaching as it unfolds in the double role of teaching and research. A true equation, here, between teaching and research that is different from the exclusive teaching of “one’s own” research—that would be unpardonable arrogance. An equation that would be to think rather than the reverse: the teaching of no matter what text—and certainly not one’s own—that one has first taken the trouble to read and that one (re)writes slowly and orally in class: something analagous to Barthes’ commented lexias but without hiding anything of the unavoidable roughness of oral writing. In short, a whole material to be subsequently noted, but whose meticulous presentation in writing—the slow-motion reading of this material—will constitute the most obvious axis of the research; a work different from the oral writing itself, as we see, but its necessary complement.

The concept of oral writing, as formulated above, is capital. It articulates the speakerly and the writerly; its practice is the occasion to demonstrate the conflict between speaking and writing. Oral writing refers to all digressions in speech (from stammering to parentheses). The many detours taken by (dis)course in teaching and speech in the psychoanalytical conversation are good examples of this.

The expression itself introduces a quite new category of concepts. Perhaps nonconcepts, undecidables, in the manner of Derrida (1972); perhaps something else (and not quite else), of notes, words caught in the genesis of aphorisms.

We have so far met two categories of concepts: the analytical concepts dominated by the logical articulation *either/or*: reading *or* writing and speaking *or* listening in readerly or speakerly texts; and synthetic concepts expressed in the form *both/and*: the text or seminar concepts subsuming the contraries—writing *and* reading and speaking *and* listening—in the higher logics of the writerly and the auscultatory; in other words, the writerly and the auscultatory are on a higher logical level than the elements (writing, reading, listening, speaking) to which they refer. Similarly, the text and seminar concepts pinpoint the contradictions between the writerly and the readerly on the one hand, and the auscultatory and speakerly on the other. The concept of “uplifting” or “sublation” (*Aufhebung*, in Hegel) precisely signifies the synthesis resulting from a conflict; an unequal synthesis, however, always identifies at least two logical levels. For example, the text concept (synthetic concept) uplifts (sublates) the conflict between the writerly and the readerly by clearly

establishing a hierarchy between the two: the writerly is of a higher logical level than the readerly in that it uplifts (sublates) the contradictions between reading and writing; the readerly does not uplift (sublate) them, but rather *fosters* the analytical identity of each of the terms: reading is not writing, and vice versa.

But oral writing, created by the encounter of the speakerly and the writerly (crossed, in the text and the seminar), does not subsume the elements in conflict (writerly/speakerly) within a superior entity; it does not uplift (sublate) them. It is therefore not a synthetic concept, nor does it articulate the link between the elements according to analytical logic. It is rather a concept (or a nonconcept) belonging to the logic of "neither one/nor the other." "Neither/nor," writes Derrida (1972, p. 59), is "*both or either*." Oral writing is therefore neither the writerly of writing nor the speakerly of speaking; it is rather *both* the writerly and the speakerly, or the writerly *or* the speakerly. The paradoxical (the right word in this case) coexistence of the two terms *reveals, fosters, a conflict*.

Thus oral writing reveals a conflict. In this it differs from the text or the seminar: it shows the very traces of the conflict that the text claims to solve (sublate) in favor of writing, or discourse in favor of speaking (discourse is written speech). Oral writing does not practice the two genres, but the tense, face-to-face encounter of language and the soul, the very locus where the subject of education grows.

It will also be noted that teaching is like a subset of speaking, and research a subset of writing. Oral writing thus practices the encounter of teaching and research; there it jealously fosters the conflict in whose heart a sizeable part of knowledge is developed.

Teaching also fosters precious links with learning, an axis similar to that defined by speaking and listening. The classical seminar defined according to the logic of the speakerly illustrates famous links between the two poles: someone teaches, someone else learns.

Finally, imposed on the writing-reading axis, within the logic of the readerly, is to be found the research study couple implying that study—indeed, higher studies—is a first stage leading to autonomous research, nothing very revolutionary. A representation of all this is shown in Figure 2.

Writing, Teaching

Figure 2 represents all the key concepts defined or mentioned above. A combination of symmetrical crossings of the different elements noted is capable of expressing four issues of educational research: the research of listening (active listening in analysis), the reading of learning (analysis of certain communication processes), the study of speaking (communication up to the limits of oral writing), and the writing of teaching (oral writing in active listening).

The following numbered text is annotated oral writing; what I have called elsewhere the notation (Daignault, 1991, 1992) of teaching. This is a form of communication of oral writing proceeding backward along the path of the textual analysis as practiced in the active listening of Barthes' seminars. Proceeding backward means slowing down the writing rather than the reading: gathering the maximum number of variations around a particular textual

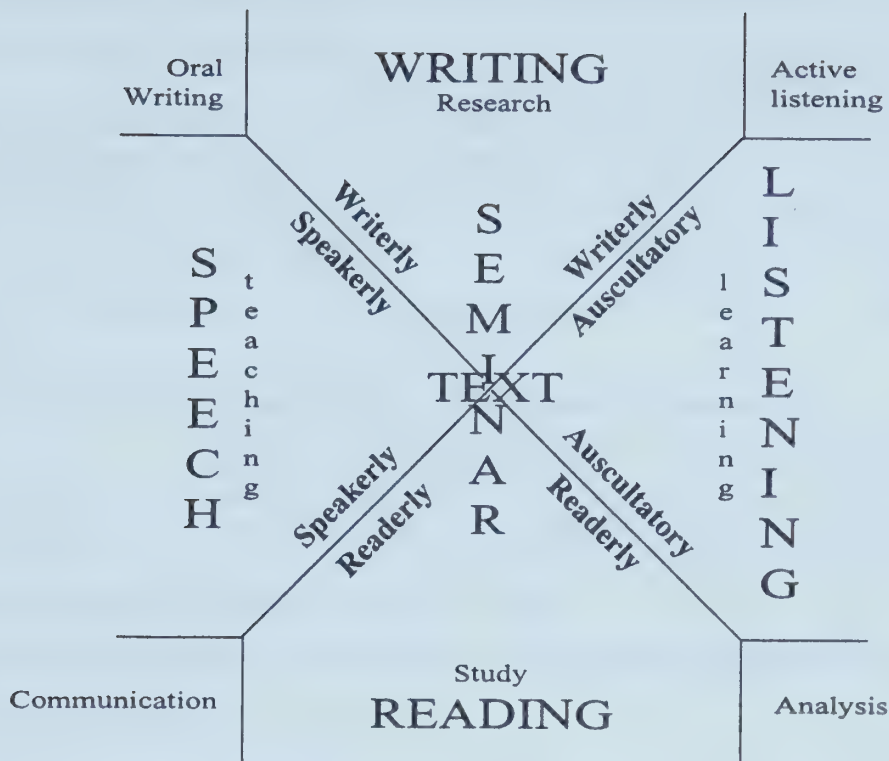


Figure 2.

statement and disposing them in the apparent order of discourse according to the criteria of esthetism: a hand-to-hand with the text.

I illustrate thus the least known of the four above-mentioned issues: the writing of teaching. And I want to kill two birds with one stone. A performative research act: the statements of the text note—and at the same time carry out—this practice itself, such as I have been reading-teaching it for the last four years in different graduate and postgraduate seminars at the Université du Québec à Rimouski and at Louisiana State University. The variations are taken from a corpus of several hundred pages composed of transcriptions as well as course notes.

In this endeavor to communicate oral writing, the first I have made public, the four remarks of a methodological nature introducing the textual analysis of *La vérité sur le cas de M. Valdemar* (Barthes, 1985) also apply, at least by analogy. First, the dissection of the text is not theoretically grounded, nor does it have to be; it is simply guided by a concern for convenience. Second, the meaning is compiled: in terms of connotations (a second meaning) in Barthes; but with me, notation (the meaning as expression). Thus it is step by step, in slow motion, that the text is written. Finally, the omissions do not count negatively; they testify to the openness of the text.

Thus, the text that you are about to read is not textual analysis as Barthes sees it; it is, rather, an oral writing, slowed by the play of the notation. Three elements will essentially be found:

1. the transcription (normal typography) of six short extracts of oral writing, taken from a doctoral seminar on Deleuze and Foucault given in the French Department of Louisiana State University, in 1989;

2. certain modifications suggested by the style and noted in two ways: (a) an expression added or substituted, in parentheses, and (b) blanks of varying lengths indicating deletions or hesitations;
3. inserted into the chosen extracts (in smaller type and in brackets) passages of reading notes taken as I was preparing the said seminar on Deleuze and Foucault; these notes are starred and begin from scratch for each new extract of the seminar.

Re-creation

(1) Principally four incorporeals: the expressible (*lekton*): (H)ave verified in Bailly's dictionary the sense of *lekton*: the translation by EXPRESSIBLE is interesting; could be SPEAKERLY, *[Pedagogy..) NAMABLE, (or) [.. (is) ..] many other things than expressible. *Lekton* means: what can be said. [.. two ..] (C)rafty for (his) part [..things: expressibles [...] or expressings ..] (A)ll the other expressions might have been confused with the SIGNIFIABLE, [.. never (...)]

the DESIGNABLE with the categories of the proposition (such) as one knows (it). The fact that Bréhier chose the expressible proves Deleuze right (:) the expressible, a fourth dimension of the proposition (.) ** (There would be a rigour and an aesthetic of expressings ..)

(T)his is a word, in a certain way, that Bréhier invents. The expressible as a noun, that has never been seen in French. (A)n expressed, that has been seen in the language, but expressible, that exists as an adjective (only). [.. And perhaps even a certain methodology.)

It really doesn't matter.

(2) (What is announced as philosophy of language with the Stoics *[I] offer ..] had never been seen (.A)nd cannot be confused with the habits taken in (the) major philosophies, [.. something (...):] treating the composition according to its three main dimensions: **signification**, **manifestation** (but in Deleuze's sense. Has the shift been noted?) (and) **designation**. (F)oucault's text [.. expressibles ..] says: signification, **expression** (and) designation. [.. and ..] Deleuze is obliged to change words. [.. some ..] what Deleuze calls MANIFESTATION, is the manifestation of the subject. But it's what has always been called in the French language, the expression. (T)here, he is caught with EXPRESSIBLE(:) he wants to reach EXPRESSED in Husserl(:) (t)he tree that turns green, [.. expressings; ..] noem in the phenomenology of Husserl(.) [.. one would like ..] he wants to reach (it).

(B)asically, EXPRESSION has nothing subjective about it. (I)s subject(ive) the manifestation of the subject [.. (...) ..] the desires and beliefs of the subject in the proposition. [.. expresseds ..] Foucault doesn't buy that. (I)nsist. ** [(T)he concept of note? The very elasticity and breadth of the frontier between the signs?]

(Deleuze) will (nonetheless) divert the word (EXPRESSION) to (plug) into EXPRESSIBLE here and (into) EXPRESSED in Husserl. He makes a sort of equation of it, but it is not at all the same thing.

*** [Musical and mathematical notations are notations of complete expression. I would even say that poetic notation - writing in verse - is also a complete notation of expression; we (are certainly in the presence) of expresseds, But pedagogical notation is merely a notation of the expressing. How can this be understood: How can this be defined more precisely and the sense appreciated?]

(3) (O)n the basis of his reading of the expressible, (Deleuze) introduces between the expressible and the expressed a very small difference (of meaning;) *[The note: ..] the event and the meaning are the same thing from a certain point of view, but very different from another point of view. Good, [.. a vague signifying (perplexed?)] ** (Break the syntax ..] the **problematic of the sensuality of the sense**. [.. rather. But why?) Deleuze says that the sense is the fourth dimension of the proposition, - we shall see (it) -, *** (Stenogrammy?) sensuality is the sixth sense. **** (Notes: stenosis of transcription; simulate the ..] (I)t can be inferred. Sensuality(:) the area of the body on which the senses come into play. [.. starting notes?] **** (Pedagogical stenography or curricula- ..] The sense comes literally to dance on this membrane, finer than mist, which is on the surface of the skin. [.. lar is a real notation of oral writing.]

(4) (I) would propose this of the sense. The virtual is the expressible; the actual is the expressed and the difference of intensity is the expressing. Why the expressing? The difference of intensity makes syntheses, syntheses of potential. (Deleuze calls) that a synthesizer. (T)o finish with Kant's synthetic judgment, to finish with Hegel's dialectical synthesis,

to have fun with the synthesizer. *[The concept of synthesizer belongs first of all to the musical world. Deleuze and Guattari prefer it to Kant's synthetic judgment. The synthesizer adds up the differences of intensity; it creates forms by empirical syntheses. The synthesizer is an affair of the body and not of the mind.] ** [At the pedagogical level, teaching is the occasion to liberate expressibles on the basis of the cultural expresseds; it is an analyzer. The insistence to note expressibles as new expresseds stems in fact from another operation of writing: the synthesizer. The notation is thus of the nature of the expressing.] *** [The synthesizer will thus proceed by differences of intensity by giving to the language a very syncopated rhythm... Hypothesis: expressibles are still qualitative

differences; the synthesizer can use them only after having translated them into expressings; the expressing would be in a way the analogical translation of the expressible. And lastly, the result - the new expresseds - would be a sort of numbering of the expressings.]

(5) Lapassade's thesis (:)* [The notes: exploded presence of ..]

(I)t is not the analyst who (makes) the analysis, it is the situation [.. subject-author.] itself.
An analyzer, is a provocation. (I)ntroduce into the institution, a certain number of things
(likely to) provoke the analysis and take notes. The analyzer(:) everything that
will make the institution move. Everything that will shake the instituted (and) replug the
instituting. **[The sign is a fundamental institution, no-one would question; there are therefore, at least virtually,
analyzers in it.] ***[(T)he reading of Barthes would be quite the opposite of an analysis; it would rather constitute a
real analyzer of readability. (T)he textual 'analysis' does not seek to unveil some hidden truth of the text. On the
contrary, it unfolds the truth in the opening and plural existence of the significations.]

(6) The hypothesis(:) *[Incarnate: ..] plug the concept of analyzer (into the theory of the expression
of meaning) in Deleuze and see (:) the expressible triggered by the analyzer(,) the
expressing work(ed by) the synthesizer and (everything that stems) from the expressed. [..
mark in the flesh (of one's) body the opening to sense: note: mark in the flesh of the signifier, presence to sense]
[(I)ncarnate, means noting about self.] *[A question to consider: how did Socrates note his thoughts?]

Final Remark

One gives a course on what one is researching and not on what one knows.
(Deleuze, 1990, p. 190)

The abandonment of a certain idea of self and its relation to the meaning that such a fragmented piece of text requires from the reader has often been denied to me in class. Then begins the real pedagogical challenge: the mediation of pertinence (Daignault, 1985). It is a question of confidence, at the threshold of an impasse: confidence in one's technical means, and confidence again with respect to the other, witness of the risk.

The key concepts mentioned in these impasses have been the object of elaborate constructions and explicit developments in class. The intertext that relaunches them again—and well beyond my class—assures their pertinence before the scientific community. The credibility of authors in French philosophy has been for long assured. Finally, the textual mass from which the passages and notes are extracted bears witness to an at least acceptable mastery of the knowledge in question.

So why again run the risk that what has apparently been acquired should not be read and understood? Because teaching is in this risk, and the research that also testifies to it, but again, and above all, because I know the other to be capable of reading. I want no other choice in pedagogy than to place my confidence in this other.

Notes

1. With respect to the literary, research is on the same side as writing: production, reading occupies a position of consumption, whereas teaching defines a third pole, that of transmission. Teaching would thus belong to the world of intermediaries, that of distribution.
2. Barthes (1984) has shown, moreover, that the analogy between the classroom and the psychoanalyst's couch implied—appearances are deceptive—that the teacher is on the patient's side and the students on that of the analyst
3. On the expression *nonconcept* concerning some of Derrida's expressions, see Scholes (1989).

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Integration of Youth into the Labor Market: Some Theoretical Considerations on a Structural/Conjunctural Issue

To compensate for the shortcomings of the economic and psychological theories of youth integration in the labor market, the authors propose a structural/conjunctural problematic through which they attempt to define the impact on integration of the combination of more transitory entities such as those related to the crisis with more lasting entities, such as those that are related to the massive implantation of the new information technologies (NIT) in production. The integration field as a process experienced by the individual is then defined as three interdependent entities: (a) vocational training (V.T.), (b) professional transition (P.T.) and (c) professional integration (P.Int.). Finally, certain integration patterns and strategies more typical of the present conjuncture are presented to illustrate various mechanisms of adjustment to labor market integration capacity, which varies according to the degree of correlation between the pertinent social structures and the conjuncture.

Pour suppléer aux lacunes des problématiques éconômistes et psychologiques de l'insertion des jeunes dans le marché du travail, les auteurs proposent une problématique structuro-conjoncturelle à travers laquelle ils tenteront de dégager l'impact que peut avoir sur l'insertion la combinaison d'éléments plus transitoires comme ceux qui sont reliés à la crise, avec des éléments plus durables, comme ceux qui ont trait à l'implantation massive des nouvelles technologies informatiques (NTI) dans la production. Le champ de l'insertion comme processus vécu par l'individu est par la suite défini en trois instances interdépendantes qui sont (a) la préparation (P.P.), (b) la transition professionnelle (T.P.) et (c) l'intégration professionnelle (Int.P.). Finalement certains "patterns" et certaines stratégies d'insertion plus typiques de la conjoncture actuelle sont présentés pour illustrer divers mécanismes d'adaptation à une capacité sociétale d'insertion professionnelle qui varie en fonction du degré de correspondance des structures sociales pertinentes et de la conjoncture.

Concurrently with our empirical research, which generally proceeds from a qualitative methodology, we are now undertaking a more theoretical and more critical reflection. Our purpose is to shed new light on the professional integration of young people based on the strategies they use, the various integration models to which they refer, and also on certain crucial structural and situational factors that we describe later. In short, the objective of this

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article is to analyze in greater detail how the integration of young people into the labor market is organized and how it varies according to the conjuncture.

Transition from School to Work as a Structural and Conjunctural Effect

One of the salient aspects of the economic situation that has prevailed for the last 15 years has been the reemergence of a form of economic liberalism known as neo-liberalism, which sees in the free market economy the forces that will settle the main economic and social problems. According to this doctrine, the solution to the problem of chronic unemployment lies in manpower training. Training and the development of workers' employability thus become the priority. This approach ultimately postulates that once employability is developed, there will be a job opportunity for everyone. However, the reality of the labor market is very different. Indeed, for an almost equal length of time, the manpower unemployment and underemployability rates have become a constant fact of life (Baby, 1987; Bengle & Laflamme, 1991). We believe that two factors in particular contribute to the present situation: first, an economic element that we shall describe later and, second, the massive and rapid computerization of all spheres of human activity, especially that of production (Baby & Laflamme, 1991).

In such a context, the sociology of education and the sociology of work must combine their efforts and break into the research field delimited by the whole range of questions relating to the labor market integration of youth, a territory so far reserved either for strictly economic research or for research of an essentially psychological nature. Although the former has tended to reduce that integration to the matching of one social subset with another—in this case the training system with that of labor market structures, as well as with the question of manpower supply and demand—the latter favors the development of workers' employability skills. Both groups of experts agree in a way on the necessity of changing or "improving" the training of future workers in the light of the changing state of the economy and the development of new technologies. Ultimately, both approaches often consider integration solely from the viewpoint of young school leavers negotiating their acquired knowledge on the labor market and obtaining a job. Longitudinal studies (Vincent, 1981) including surveys such as the CEREQ follow-up in France or those of the Quebec Ministry of Education characterize this concept of integration. They usually consider the time taken, as well as the means used, to get a first job as constituting the core of the labor market integration process.

In our view, integration is a far more complex multidimensional phenomenon because of its time frame (situational effect), the choice of jobs available (structural effect), and the different ways of dealing with the constraints imposed by each. Indeed, so complex is the phenomenon that it must be viewed within the prevailing conjuncture and the structure of society in order to reveal its social and political dimensions, as well as its economic dimensions proper. The interest of such a contextualization is twofold: first, it does not reduce integration to the dimension of a life stage to be passed through once and for all and which would basically depend on the actor's qualities alone (employability); second, it deliberately rejects any interpretation of integration as a specifically youth phenomenon presented as a homogeneous entity endowed with specific characteristics stemming from presumably universal psy-

chological traits rather than from the socioeconomic status of each young individual. Without adopting a “deterministic” view of integration, the present reflection wishes to emphasize the effect on this process of both structures and conjuncture, as well as the relative power of the position held by the actor in these structures. In other words, the general idea behind our approach is to show that integration is a complex phenomenon that assumes particular psycho-sociological configurations according to the various combinations of structural and conjunctural elements, and is affected by different and conflicting forces that shape and define it and make it a major social issue.

The Massive Computerization of Society

Apart from the economic crisis that has been dragging on since the mid-1970s (Baby, 1987) and is characterized, first, by an inflation that is hard to control except by a monetary policy that has the perverse effect, among other things, of creating growing pressure on unemployment and, second, effectively, by a dramatically high unemployment rate the present situation is also characterized by a massive computerization of society. This is due to the lightning-speed and largely unanticipated development of the new information technologies (NITs), along with their generalized implantation in all spheres of human activity, from the conception and production of goods and services to their consumption, including marketing and distribution. Our reflection on this computerization phenomenon is articulated around the following three propositions:

- *Proposition 1:* In a context of massive computerization combined with that of a long-lasting economic crisis, investment no longer creates jobs.
- *Proposition 2:* In certain forms of work organization, the implantation of the NITs may have the effect of polarizing qualifications.
- *Proposition 3:* The implantation of NITs reveals the obsolescent character of acquired training and creates considerable pressure for continuing education.

Investment and Employment

In several of his writings, Gorz (1983; 1988; 1991) offers interesting pages on the evolving relationship between investment and job creation. In particular, he states that because of the implantation of NITs in production, even an increase in investments over the years cannot ensure the creation of more jobs, and under certain conditions even leads to the disappearance of jobs. He cites the findings of a quite impressive German study on this question:

“We learn,” he writes, “that between 1955 and 1960, one hundred billion marks invested in industrial equipment created two million jobs; between 1960 and 1965, the same investment created no more than 400,000 jobs; between 1965 and 1970, it suppressed 100,000 jobs; between 1970 and 1975, it suppressed 500,000. The acceleration has continued ever since.” (1983, p. 108)

Hence when money is invested, it goes to high-productivity technologies that replace human labor very advantageously in the eyes of capital. In Japan and the United States, we already find one of the most striking examples of this profound mutation in the relations between capital invested in production and employment: certain robot manufacturing plants that are themselves

robotized. These realities not only foreshadow the long-term effect of computerization on employment, but also that of high-tech industrial investments on wage labor as such. Another frequently quoted example is that of Toyota, which for some years has had assembly plants where only maintenance and shipping staff are to be found. In this context, what will become of paid human labor as the sole or principal source of subsistence for the great majority of human beings? We shall have to resolutely envisage as an essential characteristic of the future what we have already called "the tendential drop in the proportion of paid human labor necessary for the production of our existence" (Baby, 1985b). We are inevitably progressing toward a situation where there will be less and less paid work available, at least work "sufficiently paid and sufficiently stable" to ensure a reasonable existence. Even if the trend in the short term, is almost imperceptible and constantly camouflaged by the stratagems of official labor statistics, it is nonetheless real. And it is undoubtedly this factor more than the economic components of the crisis as such that tends to transform the status of labor market integration from that of a conjunctural phenomenon, which was the case in the late '60s and during part of the '70s, to that of a structural effect, thus giving it far greater breadth and chronicity than the integration problem encountered by certain individuals in the past in a period of economic prosperity and expansion. In evolving from an individual problem to the status of a conjunctural effect, integration became, at least for the duration of the conjuncture, a social problem. In becoming a structural effect, integration becomes a chronic and permanent social problem.

Polarization of Qualifications

Apart from the plain disappearance of "sufficiently stable and sufficiently well-paid" jobs, we also know that, as a consequence of the implantation of the various NIT applications, a phenomenon of qualifications polarization effectively occurs in certain forms of work organizations. Jobs of intermediate qualifications tend to disappear. At one end of the continuum we find a mass of unskilled jobs and at the other some overskilled jobs. On certain assembly lines, for instance, one no longer finds anything between a few servicers of the computerized systems on the one hand, and one or two highly qualified technicians, the designer-programmers of the systems on the other. Studies such as those of Menzies (1981) have already shown that the highly qualified jobs thus created are usually inaccessible to most of the individuals whose jobs have disappeared or have been made obsolete as a result of the implantation of NITs in the technological turmoil. According to Menzies' study, these new jobs are inaccessible for two reasons: first, because not as many new positions are created as those that disappear, but also and above all because the gap between the qualification levels required by the new positions and those of the old is practically impossible to bridge considering the implantation time frame and present resources for further training, recycling, and reassignment, as well as the low level of qualifications of the individuals displaced; in other words, considering the distance to be covered by the disqualified individuals in such a short space of time.

The Obsolescence of Acquired Training

The NIT context is also one of great uncertainty where it is no longer possible to take for granted that the qualifications received at school will be of any lasting value, even within the perspective of adding further training from time to time over the years in the labor force. It would be more realistic for people who succeed in keeping their job to think in terms of continuing education rather than in terms of occasional recycling and further training, so great and constant will be the need to keep afloat. For it has become quite obvious that this turmoil introduced by the NITs and their rapid and unforeseeable development does not only apply to the qualifications field. It can also be seen in relation to the very existence and longevity of jobs. Birch (1985), of MIT, recalls that in the United States, for instance, 8% to 10% of jobs are disappearing annually. The American economy must therefore replace 50% of its labor positions every five years—just to maintain employment at a constant level.

In this perspective, it may be thought without any shadow of a doubt that the continuing economic crisis and the implantation of the NITs not only do not cancel out their respective effects, but combine in such a way that in certain cases and under certain conditions the effects of the one enhance or amplify the effects of the other. Thus not only does the arrival of the NITs in production not solve the unemployment inherited from the economic crisis of the mid-'70s, but it actually tends to aggravate it under certain conditions by turning it into a chronic and structural phenomenon that is in the process of outlasting the conjuncture itself.

*Integration Cannot be Reduced to
a Question of Matching Two Structural Subsets*

What can we observe from the studies conducted to date on the question of youth labor market integration? We can state first of all that most of the present theories on youth integration are in fact hardly more than reception and social integration theories. Indeed, they refer far more to society's actual or potential capacity, more particularly the division of labor, to integrate, absorb, and assimilate, in the almost biological sense of the term, young people as they leave their professional preparation (V.T.). Moreover, these theories postulate implicitly or explicitly that this reception capacity is in a way unlimited, in other words, if the young are well prepared, if they are "employable," there's a place for everyone.

As we noted above, these theories are essentially based on the articulation of the training system and the labor market. They try to identify and then explain, probably in order to predict its evolution, the varying adequacy of the training structures and contents on the one hand, and the employment structures, as well as the evolution of qualification requirements on the other. In this sense, we have already indicated (Laflamme, 1984) that the principal theories on youth labor force integration are in fact economic, or even simply demographic theories. This is especially true with regard to human capital theory and to the job search and dual labor market theories.

From the theories and the studies they inspire, we can deduce among other things that the more qualitatively and quantitatively precise the matching of school and work is at a given moment, the fewer problems of social and professional youth integration there are. What we wish to stress at this point in

the discussion is that however perfect the match may have been at a particular moment, if there are not "sufficiently stable and sufficiently paid" jobs for everyone, the problems of both social and labor market integration remain, the perfection of the match having little to do with the question.

Among the principal shortcomings of existing theories is, first, the fact that they are predominantly structural and therefore cannot take account of questions relating to youth integration except through factors respecting the degree of match between two structural subsets: essentially the training structures of which the school remains the pivotal point on the one hand, and the employment structures for which companies are principally responsible on the other. Because these theories are predominantly structural, they can also be accused of generally paying too little attention to the conjunctural aspects of the question that under the circumstances that interest us are of vital interest.

Integration as the Product of Psychosocial Strategies

We must also point out that these theories cover only the objective and macro-economic aspect of the process. They usually overlook integration viewed as the product of social as well as individual strategies. In this sense, they leave aside the subjective aspect of integration—the process as it is understood and experienced by individuals and different categories of individuals, to focus only on the macrosocial process presumably controlled by economic mechanisms. However, as Tanguy (1984) so accurately puts it, recent developments in the social sciences suggest turning, for a time at least, in other more fruitful directions the explanation that will help to reveal what has so far remained the hidden face of the problem:

In this field as in others, the quest for structural, economic and social determinisms gives way to those of the actor's strategies. We may therefore agree with Alain Tourain on a "return of the actor" to the centre of sociological analysis, even among those who do not adhere to the theory of social action. (p. 108)

Finally, it should be noted that these theories, even if they do help to establish fairly well the topicality of the macrosocial problem of integration, that is, "the extent of the damage" at a given moment throughout a given society, do not, however, spontaneously suggest palliatives or better, realistic solutions to the problem either at the macro- or microsocial levels. At most they serve to support government policies that take for granted that when the match is not perfect it is always the school and the educational system that are at fault. The state of the economy in general and the state of the job market in particular are consequently never questioned in the search for a solution to the integration problems encountered by youth. It is generally these studies that, often without their knowledge, justify the school's alignment with the short-term requirements of the division of labor, especially that of corporate profitability. Yet the social responsibilities in the matter are not always as clearly delimited, nor defined in such a unidirectional manner. Clémenceau (1983) recalls that within the framework of studies done by INSEE and CEREQ in Paris, it was possible to establish a certain number of factors related more to what might be called a question of "shared responsibilities."

In particular, it was revealed that among the crucial factors, the conditions under which youth enter the labor force, some did not relate to youth characteristics nor to the functioning of the educational system, but more directly to the overall management of manpower and its sectorial components.

Moreover, a number of investigators have already indicated, each in their own way, the unique character of today's integration context. Thus Le Bras (1983), perhaps addressing the question of social integration rather than that of job market integration proper, recalled that:

Now, the end of studies no longer corresponds to the obtaining of a job, entry into the labor force no longer entails marriage, marriage is not the beginning of sexual activity nor is it followed by the immediate birth of a child. While these events are separated by periods of time, they no longer occur in a single order: people go from a job to studies, they marry, they divorce, they leave home and return to it. Instead of a progression, one has the impression of a coming and going, a hesitation perhaps encouraged by the parents' generation, and certainly the blocking of economic opportunities.

In a study in which youth integration is viewed from the more general angle of wage relations, Bel and Mouy (1984) emphasize on several occasions this specificity of the integration process that is conferred on it by the present conjuncture, insisting especially on this particular aspect that concerns the introduction of the NITs into production:

it is not merely a period of transition between two states (from that of student to that of worker), integration also functions as a phase for young beginners to adjust to the needs of the production system and to all the changes in the methods and places of production. (p. 24)

Further on, they spell out the limitations of the theories of the two systems in equilibrium by stressing the effect of the conjuncture on the deployment of new integration strategies.

It [insertion] can no longer be interpreted solely as a process varying in length according to the educational system's degree of adjustment to the labor market, but as a process of social relations during which each actor tries to deploy a strategy according to his/her own resources. (p. 26)

Coriat and Zarifian (1985), for their part, have focused more on the differential effect of the conjuncture on the integration of various social categories through what they call "the new automation." In this perspective, not only does the conjuncture not affect all categories of youth in the same way, but it also affects their integration differently:

Apart from its effects in the workshop considered separately, the new automation—on account of the directions it takes—raises questions which concern the fate of whole categories of manpower.

Among the categories of workers threatened by the present technological situation with what Coriat and Zarifian (1985) call a process of "social exclusion," they single out young workers and more particularly those with little education or skills.

In short, the reason why the problems of youth integration are emerging today in an entirely new light and are to a certain extent unprecedented in the

contemporary era, is because they culminate finally, at least for a good number of the most underprivileged youth, in what Clot (1982) calls a process of "objective marginalization." Not so long ago, for example, during the '60s, marginalization, at least among the better educated youth, was mainly the result of a decision, a sort of political and social choice expressing both a rejection of the social order of the day and the hope for an ideal society situated "elsewhere," especially through the "communes" experience. It was then a question of what we might call—as opposed to the present forms of marginalization—a "subjective and deliberate" marginalization. Today, fewer and fewer young people choose to stay on the periphery of society. It is society that increasingly keeps them there, marginalizes them objectively, being unable to integrate them into the labor force or admit them to full citizenship status. Clot stresses that this is not a social situation created by the youths themselves:

This objective marginalization cannot be reduced to a mere change of youth "values." The transformation of attitudes, the universal integration practices all constitute responses to a new situation and not to the effect of a cultural allergy.

We have already suggested (Baby, 1985a) that ultimately for some of them this objective marginalization they had to face, was so strongly imposed that there was no more hope apart from a social integration "by break-in," as we say a break-in theft! This is the significance we can attribute in the present context to the radical forms periodically assumed by demonstrations of youths demanding work, anti-unemployment measures, equal treatment in social programs, and so forth. The social unrest experienced last year in the Glasgow area in the UK where unemployment rates of about 80% were recorded is a good example.

From Structure to Conjuncture to Structure

In order to define transition from school to work more precisely, it therefore seems necessary to identify its components and the dynamics of their interaction and structuring. From the macrosocial viewpoint, transition presents itself as a field bordered on one side by the educational system and on the other by the production system. The dynamics of the field come both from the interdependency of the two systems and from their relative autonomy in the definition of their respective contents. Indeed, if the educational system has other functions to perform in a given social training context than that of providing the labor market with skilled manpower (Laflamme & Bengle, 1979), the system of production, for its part, does not exist merely in order to integrate this manpower.

The concept of field—insofar as it is presented and understood as the product of issues concerning which actors and institutions, bearers in many respects of divergent, and even conflicting and contradictory, interests confront each other to define and shape it—helps to give transition its multi-dimensional character. This concept is not limited to the actors and institutions interested in playing along with the issues, because it is also a structured space of positions organized according to the state at a given moment of the power struggle between the agents involved in this struggle for the definition of the issues. However, the relative power possessed by actors that constitutes the

basis of the scaling of the positions they occupy within the field may vary according to the conjuncture. For example, the harsh criticism leveled at the teaching profession by the government in the early '80s (a critical phase of the economic crisis) accompanied by a cut in salary served to a considerable extent to reposition the actors in relation to the issues of the professional preparation to be dispensed to youth. It is perhaps no exaggeration to consider as a repositioning of the actors the fact that the teachers of the secondary professional and CEGEP technical level are much more favorable to the presence of the employers' representatives than of the union representatives on the curriculum committees where the orientation of these programs are discussed (Gravel, 1988).

As an instrumental theoretical supposition, we hypothesize that the transition field is composed of three entities: vocational training (V.T.), professional transition (P.T.), and professional integration (P.Int.). However, this division of the field constitutes more than just a useful breakdown of social reality and a linear view of the phenomenon since each of the entities is relatively autonomous yet participates in the definition of the subsequent and/or former entities. However, even though a young person may perceive transition as a process through which he or she must pass, the reality is more complex insofar as the stages constitute entities that function, at least partly, independently of the actors in the sense that they too proceed from the social structures. Thus to reveal the strategies of the young who must position themselves in relation to each of the entities entails going beyond what Bourdieu (Bourdieu, Chamboredon, & Passeron, 1965) calls "the subjective intuitionism that strives after sense in the immediacy of everyday life" (p. 18). In many respects the strategies stem from the individual's internalization of the structures of the social world. In other words, the strategies—for a young Quebecer, for example—are determined by his or her class ethos and by Quebec culture. In this respect, although certain strategies transcend the class ethos and are determined by the culture of the society, others refer to it directly. However, the strategies are not merely actualizations of culture; they are also inscribed in the evaluation of the situations that the culture permits and facilitates.

The transition field lies within a broader context constituted by the intersection created by the encounter of the two aspects of the social field defined by the structure and the conjuncture respectively. Examining the notion of conjuncture more closely, it seems important to distinguish this as clearly as possible from the mere economic cycle. In the latter, there are almost perfect recurrences. Put more simply, it could be said that in the economic cycle similar causes produce similar effects. In this respect nothing resembles a recession cycle so much as another recession cycle. This is what makes a cycle "foreseeable" in the empirical sense of the term. However, in the notion of conjuncture in the sense we give it, the recurrences are less obvious because it usually comprises, apart from the economic dimension that is the essence of the cycle, an historical dimension, a cultural dimension, and a political dimension that combined result in one situation being in some way completely different from any other. It would be hard to apply the same description to the notion of conjuncture—namely that similar causes produce similar effects—for a simple reason: the probability that the same combination of such a large

number of such diversified factors could be reproduced is very small, if not practically nil. In our view, the spiral would constitute a much better graphic representation of the idea of conjuncture than the "circle" implicit in the notion of cycle because the conjuncture, like the spiral, never really returns to its starting point.

In this perspective, the conjuncture is the overall situation of relations within a society at a given time, that is, the state of relations between social groups with often divergent if not conflicting interests not only at the social level proper, but also at the cultural, historical, economic, and even technological levels. It is in this sense that we say that the conjuncture, unlike the economic cycle, is in a way unique. Applied to the question of youth transition, the idea of uniqueness of a conjuncture is well conveyed by Clot (1982):

There again, in wanting to dehistoricize the present youth crisis by confining it within the timeless structures of a biographical periodization, we may run the risk of not seeing it as a signal, a testimony, an X-ray: the crisis of a whole historical phase, lifestyles that have guided the phase of capitalist growth for the last twenty years, the historical limit attained by the social control system of the '60s.

Even the studies on transition conducted at the time, few in number, suggest that we have every possible reason to insist on viewing youth integration in society from the conjunctural angle, too. This is amply justified by the following fact: even the most famous of these studies, that conducted by the American sociologist Coleman (1974) at the request of a special committee mandated to advise the President of the United States on questions concerning youth, makes no specific reference, and for obvious reasons, to the arrival of the NITs and the massive computerization of work and production as being characteristics of the youth integration situation of the day. Yet that time is not so far distant.

Integration: A Structural-Conjunctural Problem

In conclusion, let us try to illustrate the most important aspects of the entities of the integration to labor market issue on which we focus our reflection and analysis. Figure 1 illustrates what we might call the integration structures "conMacrosocial perspectivetextualized" by the conjuncture.

Macrosocial Perspective

The reader will first note the presence of training apparatus responsible for youth professional preparation (V.T.). In theory, the knowledge transmitted should enable young people to carve out a place for themselves in the labor market and society. In practice, the current situation clearly shows that the programs of social and technical knowledge transmitted are not the only factors that determine youth integration.

Indeed, once transformed into qualifications, this knowledge is legitimated by a diploma, which has a certain power on the labor market. This power varies and fluctuates according to the conjuncture. Further, at the conclusion of their professional preparation, the young must face professional transition (P.T.) that can also assume varied configurations according to individuals and categories of individuals. This moment is characterized among other factors by the job search. Associated mechanisms, a sort of interface between school

Deliberate marginalization

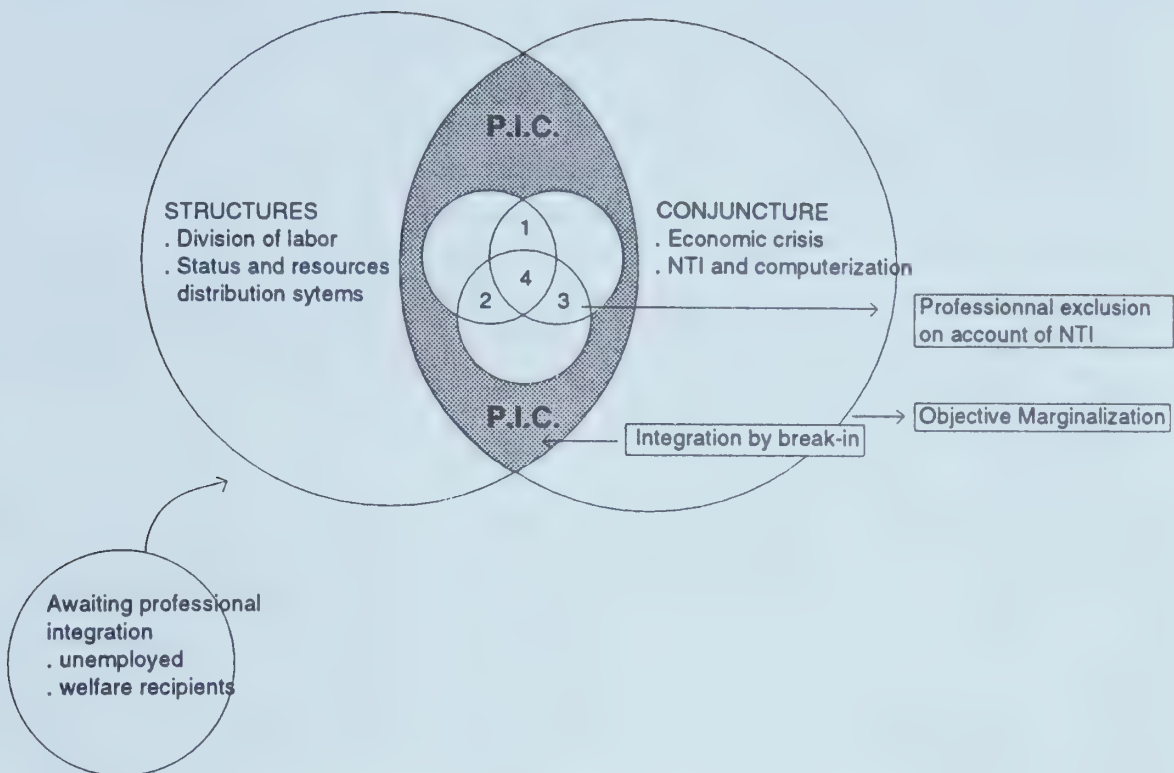


Figure 1. Labor market integration capacity.

and work, have the specific task of facilitating this period. These are the Manpower unemployment, job search centers, the numerous employability schemes, and so forth. Finally, once in a job, the young worker goes through a period of integration (P.Int.) as regards both the job itself and the company.

This process, which may seem linear at first sight, is in the present conjuncture often interspersed with less clearly configured periods during which alternation between studies, unemployment, and work somewhat upsets the order of the three above-mentioned entities. In other words, the more fluid and unstable the conjuncture, the less definitive and chronologically final professional integration will be. It is here that the notion of “intersection” between the three entities of the transition field becomes meaningful. Thus the initial professional training courses, for instance, are situated in intersection 1 which is the result of the overlap of the “preparation” (V.T.) entity and the “transition” (P.T.) entity. Under certain conditions, they may constitute “the antichamber of professional integration” (Lemieux & Baby, in press). On-the-job training as such is situated in intersection 2, formed by the overlap of the “preparation” (V.T.) and “integration” (P.Int.) entities. Precariousness, for its part, would be situated in intersection 3 formed by the partial superimposition of the “transition” (P.T.) and “integration” (P.Int.) entities (Laflamme, 1991). Finally, intersection 4, which is delimited by the overlap of all three entities, is the point where the integration strategies really operate. We shall return to this question further on.

As we have pointed out, each of these entities has its own dynamic and is also defined in relation to the others. Moreover, in their nature and importance

as well as in their degree of coincidence with the two others, they are largely dependent on the conjuncture because:

1. the professional integration capacity (P.I.C.) of a society is determined by the intersection at a given moment of two systems: 1) the existing structures, that is, essentially the division of labor, the systems of statuses, and division of labor-related resources and gratifications, and (b) the conjuncture characterized in the case in question by the two entities that we have mentioned above;
2. viewed in this way, a society's integration capacity at a given moment is not unlimited. One may imagine hypothetically that there are moments when these two entities coincide more than at other times and that under these conditions the P.I.C. is all the greater. This might be the case, in particular, of periods of accelerated economic expansion.

Microsocial Perspective

This diagrammatical presentation also helps to identify and situate the psychosocial integration strategies mentioned above. These strategies result in various integration patterns, several of which are characteristic of the present conjuncture. By *insertion strategy* (Baby, 1986) we mean "the coordinated set of actions and means employed in order to ensure the transition from school to work." By *insertion pattern* we mean "the global configuration of the entities characterizing the nature and direction of the path that marks the transition from first school-leaving to lasting access to the labor force." Apart from what we call "achieved" integration whose relative frequency and stability are determined by the P.I.C., there probably exist "satellite-patterns" in the sense that they somehow gravitate around and outside the P.I.C. We have given them a circular shape to indicate that they are "awaiting integration" either voluntarily, or on account of external factors. But we should also see to what extent notions such as pattern of social exclusion, integration by break-in, objective marginalization, subjective marginalization, and precarious work to mention only those, constitute useful, pertinent, and fruitful categories for giving a better account of the specifically conjunctural dimension of this bidimensional problem of integration. The arrows accompanying each of these models suggest the direction in which the social forces probably operate to favor or to hinder the whole youth integration process.

These theoretical considerations at this stage of our studies constitute the foundations on which is based the research activity of the Collectif de recherche sur les occupations (CRO) in the field of the professional and social integration of youth. The CRO groups investigators and students from the Education Faculty of the Université de Sherbrooke and from the Educational Sciences Faculty of Université Laval.

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Formative Assessment in a Classroom Setting: From Practice to Computer Innovations¹

The dominant values of our educational systems have gradually evolved from equality of access to equality of chance of success. Moreover, ever-increasing social pressures are being exerted to improve the school's effectiveness, hence the success of formative assessment based on regulation of learning designed to maximize academic performance. Classroom assessment based on formative evaluation is now one of the strategies advocated by most educational systems; the intention is to integrate it into educational policy. However, the constraints under which schools operate result in assessment practices that have little to do with those that would result were this policy to be implemented. The dominant mode of regulating learning based on somewhat limited traditional methods must therefore be broadened in order to develop pedagogical tools that will permit assessment to be more easily integrated into teaching. Computer innovations offer a possible solution provided they are theoretically grounded and pedagogically rooted in revised practice. A computerized assessment model based on educational diagnosis is presented to illustrate the need to gather coherent data based on a psychopedagogical interpretation jointly established by researchers and teachers, to develop computerized systems enabling assessment to be individualized, and, last, to establish testing methods that take pedagogical and institutional constraints into account. Finally, the authors propose promising ways to broaden regulation.

Les valeurs dominantes de nos systèmes d'éducation ont graduellement évolué de l'égalité d'accès à l'égalité des chances de réussite. Qui plus est, les pressions sociales visant à améliorer l'efficacité de l'école se font toujours plus fortes, de là le succès de l'évaluation formative basée sur une régulation des apprentissages visant à maximiser le rendement scolaire. L'évaluation formative fait maintenant partie des stratégies préconisées par la plupart des systèmes éducatifs; au niveau des intentions, elle est intégrée au projet éducatif. Or, les contraintes qui s'exercent sur l'école entraînent des pratiques d'évaluation peu conformes à celles qui résulteraient de la réalisation de ce projet. Il convient alors d'élargir le mode dominant de régulation, qui repose sur une instrumentation traditionnelle assez limitée, de façon à élaborer des outils pédagogiques permettant de mieux intégrer l'évaluation à l'enseignement. Les innovations informatiques offrent une voie possible, à condition

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d'être théoriquement fondées et pédagogiquement ancrées dans des pratiques révisées. Un modèle d'évaluation informatisée fondé sur le diagnostic pédagogique illustre la nécessité de colliger une information cohérente basée sur une lecture psychopédagogique établie conjointement par les chercheurs et les enseignants, de concevoir des systèmes informatisés permettant d'individualiser l'évaluation et, enfin, d'établir des modalités de testing respectueuses des contraintes pédagogiques et institutionnelles. Finalement, les auteurs proposent des avenues prometteuses pour élargir la régulation.

For the last 30 years, the assessment of academic learning has evolved considerably. Its principles and methods are increasingly inspired by values of justice and equity. These values are often implicitly, when not explicitly, stated in official policy statements and action plans.² Under the impetus given by Tyler, who broadened the field and aims of educational assessment, as well as by Bloom and other members of the Chicago School who developed a learning assessment paradigm based on the concept of behavioral objectives, these values have been at the origin of a major communication and formalization effort. Indeed, "the more clearly what is planned is expressed, and the more formally what is achieved is analyzed, the better informed we shall be about the reality and quality of learning."³ In Québec, the dominant learning assessment model is clearly characterized by a greater quest for rigor and justice. Moreover, it is marked by the evolution inspired by the theoretical developments of Tyler and Bloom.

From Equality of Access to Optimization of Success

Without a close analysis of the evolution of the concepts, principles, and practices of learning assessment (an analysis still to be made) from an historical standpoint, it seems obvious to us that the present concern for the holistic development of the individual combined with a desire to rationalize resources entails forms of assessment that can guide students' learning as well as teaching strategies *as they occur*. Moreover, the present focus on predictors of "success in life" leads us back to a quest for the optimization of academic success. When this concern for success focuses on personal development, it leads to forms of formative and criterion-referenced assessment targeting the identification of individual problems and their remediation (Conseil supérieur de l'Éducation [CSE], 1987).

In a way, this quest for success stems from the great principles of the democratization of teaching: the educational systems that advocated equality of opportunities of access now tend toward optimizing chances of success. Is this a profound and inevitable change in our societies, or a passing concern for educational performance prompted by the renewed worldwide importance of economic competitiveness? These two factors, whether acting independently or interactively, seem of increasing concern to a large number of politicians, as well as to the business community, university, and educational sectors as shown by the numerous studies and forums⁴ on the subject. Caught between the race for collective productivity and the need to preserve, indeed to promote, the student's individual right to pursue a personal itinerary guaranteeing his or her general development (Ministère de l'Éducation du Québec [MEQ], 1979), the school seeks ways to optimize academic performance while striving to promote "holistic, integral or global development" (CSE, 1990).

In this context, if the intention of assessment is *formative* with the goal of guiding the student, then teaching for its part must be *differentiated*, in other words, “be made different for each student through an adjustment that essentially concerns methods, progress, examples, etc.” (Cardinet, 1981). Ideally, this constant adjustment should take the form of an ongoing dialogue between teacher and student, a “global act of interpersonal communication” where the interaction between these two actors would serve as the impetus for the regulation of learning. Clearly this communication cannot take place without consideration of the different kinds of constraints; indeed, it is highly structured by them. Increasingly, these constraints stem from the pursuit of effectiveness.

The Place of Formative Assessment in Effective Pedagogy

The school cannot escape the numerous judgments of effectiveness, as shown by the study of Brunet, Brassard, and Corriveau (1991). Although articles on the effectiveness of organizations abound, there is no consensus about the definition of the concept or on how to measure it. This situation can be explained, first, by the state of knowledge regarding the foundations of social organizations (Kanter & Brinkerhoff, 1981) and, second, by the multidisciplinary nature of this field of knowledge (Morin, 1989). Thus, when we study the learning-teaching tandem, effective teaching consists in optimizing, through pedagogical interventions, the quality of learning in relation to the desired educational objectives. However, the customary setting in which these interventions largely take place, the classroom, is organically linked to the school, which in turn is a direct offshoot of society. In this context, effectiveness can be defined as an organization’s ability to generate actions and results acceptable to the persons and interest groups that interact with it (Barnard, 1938; Cummings, 1977; Pfeffer & Salancik, 1978). The study of effectiveness must therefore be undertaken with an interdisciplinary approach, focused on the school as the integration point. Because the criteria representing effectiveness vary according to persons or groups, and according to the use the latter make of them, effectiveness is a norm of organizational performance inevitably related to the values of the persons and groups that use it (Keeley, 1984; Van de Ven & Ferry, 1980; Zammuto, 1984). Consequently, this notion is meaningless in itself; it can have meaning only for those who refer to it in their relationships with organizations, hence the plethora of representations of this notion (Cameron & Whetten, 1983; Morin, 1989).

It is in this context that the problem of the quest for *effective* pedagogy arises as well as that of the place of formative assessment within it. For the last 20 years, the theoretical and practical contributions to the formative evaluation field have accumulated at an ever-increasing pace. But what is our present state of knowledge concerning the conditions and factors that enable it to be integrated into “real” teaching and into learning as experienced in the classroom? By real teaching we mean the pedagogical acts relating to content, objectives, and interventions expressing the goals of the official programs, but also, and above all, the day-to-day activities in the classroom as shaped by the many pedagogical, organizational, and institutional constraints. Between reality and policy, ways must be found to integrate formative assessment into the ecology of the classroom.

Broadening the Regulation

An approach designed to achieve this “integration” has long held sway in the United States. It is based on the notion of a learning regulation loop and consists in a test administered after a teaching period, and followed by interventions of a remedial nature. Thus, as shown by recent studies (Kulik, Kulik, & Bangert-Drawns, 1990; Slavin, 1987), this instrumented⁵ version of mastery learning functions at all study levels. Comparison with more traditional teaching procedures has revealed significant positive effects (on average, the effect size varies between 0.5 and 0.6) as regards both the cognitive variables (academic performance) and the affective variables (essentially attitudes regarding the contents and their teaching). Kulik et al. (1990) stress that this approach requires more study time on the part of the learner, whereas Slavin (1990) attributes the improvement in students’ performance to the fact that the approach encourages teachers to focus their efforts on the objectives given. More moderate in his appreciation of this approach, Slavin finds no evidence to support the claim that mastery learning accelerates achievement in general at the elementary and secondary levels.

In such effectiveness-oriented systems, a pragmatic approach must therefore be adopted in which formative assessment counts only insofar as it can help to maximize academic achievement by making it easier and faster. It is also important, as Perrenoud (1991) stresses, to look behind the expected effects on the learning process “to the regulatory intervention which produces them and, still further back, to the observations and representations that guide this intervention.”

The instrumented approach, originating in the United States and advocated for many years in Canada, is based on a specific formulation of instructional objectives. They structure the interventions and focus them on the mastery of the greatest number of learning tasks by the largest number of students. This teaching for mastery has practical and methodological limits that can be overcome by the introduction of mixed paradigms linking the search for qualitative data to the quantitative data obtained by measurement instruments (Dassa, 1990). Moreover, the difficulties of objectifying the regulatory process

challenge the idea of theorized teaching management, a type of scientific engineering which would permit learning situations to be mastered with as much certainty as building bridges because each element of the situation could be analyzed and controlled for itself. (Cardinet, 1988, p. 168).

These epistemological difficulties inherent in mastery learning, and particularly its central element, regulation, have been responsible for various attempts to broaden formative assessment. Originating in francophone Europe, this movement has been adopted by francophone Canada, especially by various Quebec researchers (see Scallon, 1988).⁶ Situated between an overly rigid theorization divorced from the issue of effectiveness and a technicity divorced from didactics and the psychology of education, this broadening of formative assessment strives to be sufficiently pragmatic to permit the optimization of learning as well as a redefinition of regulation. The latter must be amenable to the integration of didactics and the new technologies into the assessment

process. However, to be effective in the school context, regulation must be grounded in classroom assessment practices.

Toward a Conceptual Framework of Assessment Practices

The effects of assessment practices in the context of academic learning have been the subject of many studies. It is now well established that these practices have a strong impact both directly on academic performance itself and on the affective variables indirectly influencing learning. According to Crooks (1988), assessment carried out within the classroom setting has a marked direct and indirect impact that can be either positive or negative. It is therefore essential to conduct systematic studies on assessment practices. Research in this field is all the more necessary in that present educational systems ascribe a central role to assessment in the pedagogical management of learning as well as a preponderant role to the teacher as the person primarily responsible for this assessment.

In this context, teachers' assessment functions can be defined essentially as the processes and procedures that allow the student's level of mastery to be assessed, as well as the effectiveness of teaching, to be judged from an operational perspective of decision making about planning the student's progress. When these functions are performed in the classroom, the assessment naturally broadens out from its customary definition of value judgment based on a formal measure obtained from a test or examination to one that is also based on informal qualitative data obtained from oral questions, spontaneous observations, and so forth. This definition is at the core of the so-called classroom assessment movement, an increasingly popular approach to student assessment (e.g., see Stiggins, 1988).

At the level of processes, it is important to consider the impact of the teachers' affective variables, such as their value systems, beliefs, and attitudes, on their assessment practices. The latter may be defined as being the set of interactions between teacher and student that take the form of oral, written, or nonverbal communication aimed at collecting the information necessary for the student's future progress. This interactive exchange must, therefore, be accompanied by related information concerning the students' affective variables (self-concept, beliefs, and attitudes). Further down the line, when the processes are expressed as observable procedures, two types of behavior lend themselves to observation: what the teachers *do* in the classroom and the description they give of this, namely, *what they say they do*.

Thus broadened, the domain of reference of these assessment practices may be subdivided into eight general categories. This domain has been validated by experts and reflects the different stages of the assessment process, from intention to decision (Dassa & Dumoulin, 1990). These categories are:

1. The aim of the assessment;
2. The means of the assessment;
3. The context of the assessment;
4. The use of the means of assessment including preparation, administration, and correction of the measurement instruments as well as implementation of the means of gathering informal qualitative data;
5. Statistical analyses;
6. The means of informing students, parents and various educational agents;

7. The characteristics relating to the quality of the assessment;
8. The regulatory aspects of the assessment.

This domain of reference may serve directly as a basis for the elaboration of a questionnaire to be administered to teachers and concerning their assessment practices. However, this type of information must be completed by observation of some of these classroom practices using a grid (or a scale). The methodological constraints specific to this latter type of instrument require appropriate structuring for the classroom environment. This leads to further specification of the domain of reference described above, which must necessarily concern the following categories:

1. The general pedagogical context of the assessment acts performed in the classroom;
2. The general pedagogical context of the assessment material used in the classroom;
3. The general assessment context, that is, obtaining the information (from examinations, tests), using the information interactively and retroactively (in discussions, exchanges), and proactively (in planning assessment and instruction);
4. The general structure of the lesson into three parts: introduction, development, and conclusion;
5. The characteristics of the teacher's nonprescriptive verbal communication;
6. The characteristics of the teacher's prescriptive verbal communication;
7. The characteristics of the teacher's affectively influenced behavior;
8. The characteristics of teacher/student exchanges.

The domain of reference of the proposed assessment practices, as well as the specifications relative to the direct observation of classroom assessment acts, might through the development of relevant measurement instruments serve as a basis for a general assessment practices data management model designed for decision making

1. by the teacher with respect to his or her own teaching;
2. by the various educational agents with respect to the administrative and pedagogical backup given to teachers regarding ways of functioning that have pedagogical impacts.

The ultimate goal of such uses would be to adjust the pedagogical and organizational practices subject to institutional constraints in order to better integrate assessment into teaching. This is why many Quebec studies have tried to describe both teachers' assessment practices and their beliefs and attitudes with regard to formative assessment practices.

Assessment Practices: Between Policy and Constraints

Recent studies (Burelle, Gadbois, Parent, & Seguin, 1991; Gadbois, Burelle, Parent, & Séguin, 1991) show that teachers in the Greater Montreal area, although understanding and accepting the justification for formative assessment, are reluctant to take all the necessary steps to integrate it into their daily practices. "There seems ... to be a discrepancy among the teachers between theory and practice concerning formative assessment. Indeed, they pay lip service to it but consider that its practice is unrealistic in the present educational context."⁷ Thus there is a difference between the accepted theoretical concept and the will to apply it. This resistance to change might be explained by

various factors related particularly to the teaching load, as well as to inadequate training, especially in measurement and evaluation.

Dassa and Dumoulin (1990) and Dumoulin (1991) studied the practices of some 100 secondary level mathematics and science teachers in the Montreal area. The authors sought to establish a detailed profile of how the assessment of student learning is practiced by these teachers. These studies showed that the great majority (83%) of the teachers sampled had never taken a basic learning measurement and evaluation course. Moreover, a quarter of them had received no form of further training in this field. This shortcoming may explain why teachers are reluctant to construct the required measurement instruments themselves. Furthermore, according to Dumoulin (1991), the teachers had relatively little time to cope with individual problems. The most common type of interaction engaged in by the teachers reflects a concern for the collective assessment of the class, leaving little room for diagnostic and individual functions. In this context, it seems as difficult to integrate instrumented and systematic formative assessment into the classroom as diagnostic assessment related to the students' individual learning.

In the framework of a series of studies concerning the factors influencing educational diagnosis,⁸ an observation scale⁹ was developed and validated according to the domain of reference proposed above. This instrument was used to observe 21 Montreal area teachers at the elementary, secondary, and college level during 107 15-minute sessions. The teachers devoted on average 46% of their time to behaviors designed to guide students in their learning process, that is, behaviors actually stemming from the teacher's assessment functions. The percentage of time devoted to assessment acts tended to drop from the elementary level (63%) and first cycle of the secondary level (62%) to the second cycle of the secondary (48%) and college (32%) levels. Finally, it should be noted that teachers who had received training in measurement and evaluation carried out on the average about twice the number of assessment acts performed by the teachers with no training in this field.

These studies reveal a profile of the teacher in complete agreement with the values and principles of formative assessment but inhibited in his or her actions by a lack of teaching tools and training. Moreover, as for the individualization of remedial strategies, teachers are likely to attribute the causes of their students' problems to factors other than that of their own teaching. Gaps in prior knowledge, students' family problems, and behavioral difficulties seem to constitute a moral shield that enables teachers to limit their corrective interventions. The teacher usually makes a collective review of the content that presents problems for the whole class. More rarely, when the pedagogical organization of the school allows it, the teacher devotes a limited number of periods (one hour a week at most) to individual "remedial" sessions. The latter are limited to a few students presenting serious problems. This observation concurs with various analyses concerning the *differentiation pressure* that occurs when formative assessment is part of educational policy, but because of lack of means cannot be practiced consistently. "This results in conflicts and frustrations, thus a regression to teaching and assessment methods more in line with the teachers' constraints" (Perrenoud, 1988).

In short, these Quebec findings parallel other studies on assessment practices done in Canada (Rogers, 1990) and the United States (Stiggins, 1988; Stiggins & Bridgeford, 1985). The teachers spend most of their time performing assessment acts by basing themselves mainly on informal performance assessment methods. They carry out these assessments with the help of instruments they develop themselves as best they can; their measurement and evaluation training is often nonexistent and they lack tools. Finally, all stress the problem of lack of time to develop (or acquire) quality tools and integrate them into their teaching.

The Need for Tools and the Computer Technologies

We see that the pursuit of individualization of learning leads to differentiated teaching. However, the latter is impossible in an environment subject to as many constraints as the school, and cannot be effective without support that meets the needs. Unless there is a thorough rearrangement of educational structures and organization, we must turn to the new technologies. Now in Quebec as elsewhere, it is becoming increasingly clear that computer technologies offer pedagogical possibilities that are well worth exploring (e.g., see Berthelot, 1987).

In our opinion, information technologies, and in particular microcomputers, can help implement educational practices in accordance with the principles of formative assessment. First, they enable data to be collected and analyzed coherently, and second, they help to improve teaching and student learning. The various applications of these technologies in education, or Computer Based Learning¹⁰ (CBL), make it possible to develop instructional support tools centered on the learning processes (CSE, 1990) and thus to fully support a differentiated type of teaching known to be linked to formative assessment (Huberman, 1988).

The results of 30 years of research on CBL have established quite consistently that it has a positive impact on students' performance (Fletcher, Hawley, & Piele, 1990; Kulik, Bangert, & Williams, 1983; Kulik & Kulik, 1985; 1986; 1987; 1991; Suppes, 1966). However, to do so, three conditions had to be met: (a) the breakthrough into the educational market resulting from the introduction of microcomputers in the 1980s; (b) the adoption of the technology by teachers and its integration into their teaching practice; (c) the integration of technology into educational policy, as advocated in official studies programs. We have only to note the increase in the number of computers in American schools (Baird, 1989) to understand the current importance of CBL:

1. 75% of schools that had not used computers before 1980 were using them in 1985;
2. the percentage of high schools equipped with 15 computers or more rose from 10% to 56% during the period 1980-1985;
3. in 1984-1985, about 500,000 teachers were using computers with 15 million students;
4. the number of school districts using CBL rose from 18% in 1981-1982 to over 95% in 1986-1987.

In 1986, investments in computer software and equipment in these school districts reached \$700 million, which illustrates the schools' expectations with regard to the educational potential of the computer (Wise, 1989).

Elsewhere in the world CBL has also been the object of implantation programs (formal or informal, official or unofficial). An example worthy of note is the British Microelectronics Education Programme, which in the early 1970s marked the development of this pedagogical innovation in a particularly decentralized educational context (Hubbard, 1985). Other initiatives are to be found in various Western European countries, which in varying degrees have proved successful and have had an impact on pedagogical practice (Council of Europe, 1989; Frey, 1986; Hebenstreit, 1986). In one way or another, these initiatives have contributed to the presence of CBL in European countries today.

In Quebec the use of microcomputers in the school took off in the 1980s. It is estimated that in 1990 the 2,400 public schools in Quebec with an enrollment of about 950,000 students at the elementary and secondary levels (not including vocational training and adult education) counted nearly 36,500 microcomputers that could be used for educational purposes. About 60% of elementary schools are equipped with computers, and just fewer than half of the computers (43%) are to be found in the secondary schools. The number of students per computer for the schools as a whole is 26, with an average of 15 machines per school. The percentage of secondary students affected by school computers is estimated at 29%. This percentage rises to 56% at the elementary level. At the secondary level, the percentage of user time for computer science teaching is 44%, whereas 40% is allocated to other CBL applications. At the elementary level, CBL represents 89% of use. It should be noted that 70% of the computers function on the DOS operating system. Moreover, the educational software available (on the average 26 programs per secondary school and 30 per elementary school) is still limited. The situation is similar as regards the human resources specifically allocated to microcomputer teaching (present in only 7% of schools). Finally, it is estimated that 48% of teachers make use of the computers available (Danvoye, 1990). It should be noted, however, that little use seems to be made of the microcomputer for learning assessment purposes: in 1985 a survey established the rate at 19% for teachers at the elementary level and 31% for secondary teachers (Berthelot, 1987).

However, the impact of CBL, like that of any innovation, depends on its integration. Indeed, the introduction of innovation into educational practice (for example, within the framework of a course and not in an isolated "experimental" situation) must be followed by a process of appropriation by the teacher (Dassa, 1988). A certain number of factors are known to play an important role in this appropriation (Chomienne, 1986; Chomienne & Vázquez-Abad, 1990). Among these factors is the teacher's ability to independently develop innovative instructional interventions to fit in with his or her own practices, teaching style, and available resources (technical support, participation in information networks, political support).

In Quebec support for these instructional interventions has taken various forms over the last decade. Major government investments in equipment were followed by efforts to encourage and subsidize the production of educational software by local firms. Thus, between 1984 and 1988, the Direction des ressources didactiques allocated \$4.2 million to 29 companies for 76 different projects; these led to the production of 47 software programs in 1988 (Bibeau,

1988). To find out more about current needs, the technological prospects, and the factors specific to the implementation of CBL, the government funded, from 1985 to 1990, a research and development center (APO QUÉBEC) and more recently regional educational microcomputer centers (CEMIS) the mandate of which focuses on practical applications. Finally, the importance of this type of innovation in the official programs is starting to be recognized. In this regard, it should be noted that the government has just published a directory of software for secondary level science teaching, which coincides with the development of new programs in which CBL will probably play an important role (Délisle, 1992).

With respect to computer-based testing, we should mention the existence of a measurement instrument bank (B.I.M., 1987) concerning different programs at the elementary and secondary level. This bank enables the various educational organizations to acquire measurement items and instruments or to produce them in conjunction with the company that manages the system. However, B.I.M. is not directly accessible to teachers, nor does it offer many items or examinations designed for strictly formative or diagnostic purposes. Thus it does not necessarily meet specific classroom needs. The way the bank is used underlines the fact that B.I.M. is not designed to support differentiated teaching methods based on regulation and remedial approaches.

Concerning the effects of microcomputers on learning, studies report that these are usually positive. In comparing traditional teaching with CBL (whatever the application), the latter proves superior: the students seem to learn more, better, and faster. Moreover, they appreciate their course more and develop a favorable attitude toward computers (Kulik et al., 1983; Kulik & Kulik, 1985; 1986; 1987; 1991).

The Importance of Instructional Design in CBL

Classical applications such as drill and practice in mathematics (Hativa, 1988; Middleton, Curran, & Moscardini, 1989), like more recent applications such as microcomputer based science laboratories (Tinker & Papert, 1989), seem to hold great potential for academic success. However, their impact on learning may well be due in good part to the organization of content and the planning of the instructional interventions required by the CBL design rather than to the actual utilization of the computer (Clark, 1985; Viau & Stolovitch, 1987). It is now recognized that to obtain positive effects on students' learning, software is needed with effectiveness ensured by a theoretically grounded and pedagogically solid design (Baird, 1989). Thus the systematic design of instruction probably has a greater influence on academic results than the use of a particular medium or technology. For example, the success of a performance responsive drill and practice software (Vázquez-Abad & Lafleur, 1990), whose design is based on research findings in cognitive psychology and educational media, is probably due to its conceptual foundations rather than to its use of the computer. The presence of microcomputers in the school, therefore, seems to allow the development of systems designed to support teaching practices that favor the regulation of learning in accordance with the principles of formative assessment.

Computers and Educational Diagnosis

In the following section we present the general conceptual framework of a model¹¹ based on the operational definition of educational diagnosis proposed by Dassa (1988, 1990), a brief description of a system of diagnostic tests designed according to this model, and an assessment of its effectiveness.

An integral part of formative assessment, educational diagnosis consists of (a) identifying the error; (b) defining the nature of the error; (c) describing the pedagogical context in which the error is made; (d) trying to relate the cause(s) of the error to a learning paradigm; (e) proposing corrective interventions coherent with the teaching methods and technology used and possibly based on a predetermined theoretical framework. In the present educational context, the implementation of any model based on educational diagnosis should make use of the computer in order to ensure individualized measures and interactive learning. The development of the model is based on a retroactive research strategy involving both researchers and teachers. The researchers are responsible for the theoretical and technical support in order to make the model operational with the help of a series of learning units, while the teachers experience the actual implementation of the model. This approach allows the integration of a great number of factors concerning the curriculum, the educational system, the organization of teaching, as well as the teachers' and students' specific characteristics.

Based on this model, a computer-based system was developed with an aim to maximize the *coherence* and *effectiveness* of the information obtained. The coherence of the diagnosis is ensured by an item bank with a three-dimensional structure: diagnostic context, notional content, and cognitive ability. This structure allows the items to be categorized and ordered, thus defining a diagnostic taxonomy. This approach, when coupled with an adaptive selection (based on a student's replies), permits a *structural diagnosis* that identifies the nature of the error observed according to the diagnostic taxonomy used. In this context, the coherence of the information refers to the homogeneity of the description of the errors as well as to the logical interpretation of their causes. It should be emphasized here that the system has been validated in close collaboration with teachers who contributed for two years to its design, testing, and evaluation. Moreover, the questions posed by the multiple-choice items were established on the basis of an in-depth error analysis carried out jointly by the researchers and teachers. The resulting *causal diagnosis* gives the teacher a psychopedagogical explanation of the error, which reflects, apart from the usual cognitive factors, his or her own teaching practices. In this sense, the causal diagnosis resulting from the administration of the diagnostic tests constitutes a management tool that respects not only the content and programs of study, but also the ecology of the classroom. The effectiveness of the information obtained is thus defined by its ability to generate the most appropriate remedial interventions. Moreover, the system's dual mode of operation is adapted to the school's ecology. It can be operated:

1. in the *laboratory*, where the whole class takes a computerized adaptive test pertaining to one or several specific objectives in order to establish a general profile of the students' individual and collective difficulties;

2. in *remedial teaching*, where the teacher meets, outside the classroom, a few students presenting problems considered to be important, and then makes an in-depth diagnosis in several stages according to the diagnostic dimension(s) he or she chooses.

It should be noted that in such an environment the learning assessment is based on both qualitative and quantitative data and is integrated into the teaching strategies and learning processes according to a retroactive, interactive, and proactive rationale (Allal, 1988). The retroactive aspects are to be found in the collective laboratory-mode assessment procedure. Although the results are available as soon as the test is over, because of schedule constraints the teacher interprets these results and uses them during the next class. The interactive assessment occurs during individual remedial sessions. These are special meetings between the teacher and the student having difficulty, during which the teacher uses structured diagnostic data resulting from a computer-assisted adaptive test. Teacher and student interact through a diagnostic report (produced immediately) that presents a profile of the student's difficulties in summary form that can be used to guide the remedial measures. Finally, the collective and individual diagnostic profiles enable the teacher to establish a proactive instructional intervention strategy.

This system has been tested in two schools in the Montreal area, one private and the other public. In all, four Secondary II mathematics teachers each administered eight testing sessions related to an equal number of objectives. The approximately 150 students participating were grouped into five experimental classes. Five other classes grouping 150 students served as a control group. This first validation phase revealed that the effect size was about 0.7 (sigma). This first indication of the model's effectiveness is encouraging in the light of similar formative assessment research (cf. Slavin, 1987).

Computerized Diagnosis as an Integrating Factor

At present, the system is based on a psychopedagogical analysis from which the item bank is structured. The item selection strategy is then based on this structure so as to optimize the structural and causal diagnosis. This procedure is obviously distinct from the adaptive tests based on Item Response Theory (IRT), which estimates unidimensional abilities. We know, however, that IRT allows optimal information collection in a unidimensional environment (of items). An interesting avenue for further research would consist in identifying groups of items each related to a single factor situated in the diagnostic structure described above. In this way, the diagnosis could still be based on this hierarchical structure, which would define testing stages ordered according to pertinent didactic and pedagogical aspects; each stage would include IRT-based information collection steps. Seen from this viewpoint, the pursuit of computerized diagnostic testing strategies becomes a possible way to achieve broadened and improved regulation offering greater effectiveness.

Notes

1. This article describes research carried out under a grant from the Social Sciences and Humanities Research Council of Canada (No. 410-89-1010).
2. This is notably the case in Quebec where the *Politique générale d'évaluation pédagogique* (General educational assessment policy) of the preschool, elementary, and secondary sectors

- in force since the early 1980s specifies justice and equality as values underlying educational assessment.
3. Politique générale d'évaluation pédagogique, Ministère de l'Éducation, Direction générale du développement pédagogique. Québec, Document 16-7500, p. 6.
4. In this regard see the research and documents produced by Forum entreprises-universités, especially "Nos accomplir: Apprendre pour l'avenir," Montréal, 1991.
5. The instrumented approach is subdivided into two types of procedures. In the LFM procedure (Learning for Mastery) inspired by Bloom all the students progress at the same pace controlled by the teacher. On the other hand, Keller's PSI procedure (Personalized System of Instruction) enables students to progress at their own pace.
6. Mention should also be made of the contribution of the journal *Mesure et Évaluation en Éducation*, which serves as a joint forum for French-speaking researchers and specialists in Canada and Europe.
7. Results of a survey of 200 elementary teachers in the Montreal area. See in this regard Parent, Séguin, Burelle, and Gadbois (1992).
8. Elaboration d'un modèle d'intégration du diagnostic pédagogique aux apprentissages scolaires. SSHRC-Canada, Grant No. 410-89-1010, Clément Dassa, principal researcher.
9. See Fontaine (1991).
10. *Applications pédagogiques de l'ordinateur*, the term most frequently used in Quebec to cover all uses of computer technologies for teaching, assessment, and learning purposes. Included in this term are assessment applications such as tests and computerized diagnoses as well as instructional applications such as tutorials ("intelligent" or not), drill, simulations, and games.
11. This model was developed in the framework of the research mentioned in note 8. For further details concerning the choice of testing strategy, see Dassa and Auger (1991). For an illustration of the model, see Auger and Dassa (1991).

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One Child, Many Environments: Continuity or Discontinuity in Kindergarten and School-based Day Care Programs?¹

A growing number of children are attending both kindergarten (K) and school-based day care (C) after a prior experience in preschool day care. Consequently problems of harmony and coordination are encountered at an age that calls for special attention to continuity, stability, and quality of experiences. The first of the two studies reported in this article assessed 19 K and 15 C on an environment rating scale. Analyses show higher and more homogeneous results for K when globally compared with C environments. The same superiority appears when comparing K-C dyads of the same school in 12 cases, whereas five dyads are similar and 2 C are rated higher than their K counterpart. The second study was aimed at identifying factors of discontinuity in communication between K teachers (KT) and C educators (CE). Answers to a specifically designed questionnaire show differences between KT and CE on age, education, and experience. They indicate a general agreement on perceived level of relationship, satisfaction with this relationship, content of communication and knowledge of child's experience in other program, and of counterpart's educational practices. Results also indicate low levels of information and communication between KT and CE and pinpoints obstacles to improvement. Results from both studies are discussed in terms of risks for children's adaptation and development.

Un nombre croissant d'enfants fréquentent à la fois la maternelle (M) et le service de garde en milieu scolaire (G), après une expérience antérieure en service de garde préscolaire. Par

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Hélène Larouche participated as coordinator in the kindergarten/school-based project (first study in this article) directed by Madeleine Baillargeon.

Maryse Joncas acted as coordinator of the above-mentioned study.

conséquent, des problèmes d'harmonisation et de coordination se posent à un âge où une attention particulière doit être accordée à la continuité, à la stabilité et à la qualité des expériences. La première des deux études présentées dans cet article a évalué 19 M et 15 G sur une échelle d'évaluation de l'environnement. Les analyses indiquent des résultats supérieurs et plus homogènes pour les M globalement comparées aux environnements des G. Dans 12 cas, la même supériorité se manifeste lorsque M et G de la même école sont paires. Dans cinq dyades, les résultats sont semblables alors que 2 G ont un score plus élevé que M correspondante. La deuxième étude a pour but d'identifier des facteurs de continuité dans la communication entre les enseignantes de M (EM) et les éducatrices de G (EG). Les réponses à un questionnaire spécialement élaboré pour cette étude montrent des différences d'âge, de scolarité et d'expérience entre EM et EG. Elles indiquent un accord général quant à la perception du niveau de relation, de la satisfaction de cette relation, du contenu de la communication de même que de la connaissance de l'expérience que vit l'enfant dans l'autre contexte et des pratiques éducatives de la collègue. Les résultats démontrent également de bas niveaux d'information et de communication entre EM et EG et font ressortir des obstacles à leur amélioration. La discussion des résultats des deux études porte sur les risques qu'ils représentent pour l'adaptation et le développement des enfants.

The evolution of educational and social service delivery systems for young children is strongly influenced by increasing demand from families. Although this increase has been felt in every industrialized country most European countries have developed accessible free or low cost public services, whereas North America has opted for fewer, less accessible, and more costly services.

Quebec has essentially adopted the North American system, meeting first the educational needs mainly expressed by the middle class and the educational reformists from the "quiet revolution" of the 1960s. The Ministry of Education was created at that time, and one of its first measures was to set up the public, universal, yet not compulsory, kindergarten offered to all children in Quebec in the year preceeding their entry into mandatory school. Families rapidly adopted kindergarten, which since 1979 has welcomed nearly all five-year-olds, whereas programs for specific populations reach about 10% of four-year-olds (Conseil supérieur de l'éducation, 1989; Ministère de l'éducation, 1981; Tudiver, 1986).

In the early 1970s, day care centers set up by parents and advocacy groups began to receive support and recognition, thus initiating the development of day care services.² Finally, in 1979, legislation relevant to day care was enacted and the Office des services de garde à l'enfance, responsible for the application and regulation of the law, was created. Albeit much fewer than the estimated needs, day care services have since constantly grown (696,853 places for infants to 11-year-olds in 1991). Maternal employment has dramatically changed in the last two decades in Quebec, thus explaining the ever-increasing need for day care. In 1990 61.4% of mothers of children under six were in the labor force compared with 30% in 1976 (Bouchard et al. 1991). Such a major change has greatly modified upbringing practices for young children and consequently the various early childhood programs' educational and social agenda.

Today Quebec finds itself alongside most of the Canadian provinces and American states with two collective service networks for young children, created at different times, with different orientations, and operating within parallel governmental structures. Consequently, numerous problems of harmony, overlapping, and coordination are being encountered in a period when child development calls for special attention to continuity, stability, and

quality of experiences in order to foster a secure, trusting, and positive personality.

An increasing number of children attend full-time preschool day care, and upon their arrival in kindergarten (open at most two and a half hours a day) still require care and are enrolled in school-based day care. Although the actual number of children involved is still rather low (about 15% of five-year-olds, based on data from ASGEMSQ, 1991), the demand and the increase in services in past years indicate that the experience of these children should be scrutinized. In fact the most important growth in day care was noted in school-age day care, thus placing Quebec ahead of other provinces in the number of places offered to school-aged Canadian children, that is, 37% of the Canadian total (Bell-Lowther, 1991). However, apart from administrative instructions, there are no real standards regulating school-age care in Quebec. For example, the minimum educational requirements for school-based day care staff is grade 10, as compared with kindergarten teachers who must have a bachelor's degree in early childhood and elementary teaching. This kind of discrepancy in the framework of the various services is more than cause for discussion among the Quebec early childhood education groups. For all these reasons, the studies reported in this article focused on children attending both kindergarten and school-based day care.

Prior to discussing research on school-based day care, it may be helpful to review the evolution of research on preschool child care. From the inception of day care for infants and preschool children, researchers have participated in the evaluation of these services. Numerous studies were thus provided since the mid-1970s. Three main generations of research have been identified (Phillips & Howes, 1987). The first could be summarized by the following question: Is day care useful or detrimental to normal child development? The second corresponds to the question: Which type of day care is better for children? The third attempts to answer: How can day care be improved?

The National Day Care Study (Ruopp, Travers, Giantz, & Coelen, 1979) opened the way for the third generation of studies on day care. At the request of the United States government, the study was aimed at identifying the elements most favorable to children and at estimating implementation costs. Results indicate that group size, ratios, and teachers' specialized education are related to the children's social, cognitive, and language development.

These findings gave the impetus to a great many studies that have since examined the quality of day care and its effects on child development. Most of these studies are reviewed or by Phillips (1987), for example one conducted in Victoria, BC, by Goelman and Pence. Results and those of subsequent studies confirm the relationship between most of the quality criteria and several measures of children's social, language, and cognitive development, and also add evidence of its complexity. For example, the latest United States nationwide study found relationships between staff working conditions and quality of day care (Whitebrook, Howes, & Pemberton, 1989).

Although data concerning quality in school age day care are scarce, lessons can be learned from research in preschool day care. In fact results from Howes, Olenick, and Der-Kiureghian (1987) and from Vandell and Corasaniti (1988) suggest that, here again, quality factors should not be overlooked.

As research progressed on preschool child care, the issue of continuity in child experience was raised. It has been looked at mainly from the point of view of continuity between home and day care and as being potentially linked with quality (see Peters & Kontos, 1987a).

Should continuity between kindergarten and school day care be ensured? No clear answer can be derived from the studies on continuity between family and preschool day care. For some (Cohen, Parker, Hest, & Richards, 1972), spending up to 11 hours a day on the school premises extends an already painful daily experience where children feel the pressure of criticism, evaluation, and school requirements. This feeling will be reinforced when the school day care curriculum is an extension of that offered in the primary school. For others (Alexander, 1986; Proulx, 1990), when the intervention style adopted by school day care is similar to that of kindergarten, school-aged children strongly resist as they feel babied. In short, the "correct" or "best" approach to school day care is not yet clear.

The state of the question thus set underlines the gaps in the available information and points to future orientations research should take. For instance, the interrelated effects of family and day care variables should be kept in mind. There is also a great need to remedy the lack of data on the school future of day care children, as well as on issues related to the continuity of the child's experience within numerous environments.

The term *continuity* is defined as "the commonality or similarity of attitudes, beliefs and expectations held by the various sets of caring adults "across different microsystems" (Peters & Kontos, 1987b, p. 7).

The two studies presented in this article address the issue of double attendance in kindergarten and school-based day care in the Quebec context. The goal of these projects is to provide information on the current status of the two types of services, their similarities and differences, as well as on the continuity or discontinuity that should exist between them in a perspective of quality for optimal child development.

Study One: Comparison of Quality of Kindergarten and School-based Care Environments

The first study attempts to describe two microsystems (Peters & Kontos, 1987b), kindergarten and school-based day care, taking into account a third microsystem, the family. It seeks to establish links between these microsystems and children's social and language development.

Method

Procedure

A first group of subjects was formed at the beginning of the 1989-1990 school year. Quebec City area public school boards were asked to participate; four responded and gave the names of the kindergarten teachers and school-based day care coordinators from their elementary schools who agreed to take part in the study. Children took home a description of the study, along with a questionnaire and consent form to be completed by the parents. Observations of the kindergarten environments and pre-test measures of the children were taken from the second week of November to mid-December 1989. Observation data from school-based day care were collected from the last week of January

to the end of February 1990. While subjects were present each environment was observed for at least half a day including the total kindergarten period: arrival, lunchtime, and arrival after school of the older children. Observers moved freely about the rooms further questioning teachers when required. Post-test measures of the children were collected from the last week of April to the third week of May 1990. All measures were taken by three trained experimenters. Two rated environments and all three shared the task of child assessment, making sure that the same person tested all children on each specific measure. The following year a number of children and environments was added to the original sample following identical schedules and protocols.

Sample

The final sample consisted of 144 children from 19 kindergarten classrooms located in 15 public elementary schools under the jurisdiction of six Quebec City area school boards. They were divided into two groups: 69 were not attending any kind of regular care facilities before entering kindergarten, returning home to parent(s) after school; 75 attended both kindergarten and school-based day care at least four days a week, and were enrolled in pre-school day care before kindergarten.

Instruments

Kindergarten (K) and school-based day care (C) environments were assessed by the Early Childhood Environment Rating Scale (ECERS, Harms & Clifford, 1980). The ECERS is widely used to assess quality of preschool day care mainly in the United States but also in countries such as Canada (Baillargeon, Gravel, Larouche, & Larouche, 1989; Goelman & Pence, 1987, 1988; Schliecker, White, & Jacobs, 1991), Bermuda (Phillips & Howes, 1987), and Germany (Tietze, 1989, see Clifford & Harms, 1989). It has also been used to assess K classrooms (Bryant, Clifford, & Peisner, 1991). A total of 37 items cover seven areas: personal care routines, furnishings and display for children, language-reasoning activities, fine and gross motor activities, creative activities, social development, and adult needs. Each item is rated from one to seven on a Likert type scale providing a total minimum score of 37 points and a maximum of 259 points. The ECERS was translated into French and used both in the present study to assess K and C environments, and in a former study conducted in preschool day care centers from the same urban area (Baillargeon et al., 1989). Internal consistency analyses conducted on the data yielded the following coefficients: K ($n=19$) $\alpha=.895$, C ($n=15$) $\alpha=.972$ and preschool day care centers ($n=16$) $\alpha=.805$. Inter-rater correlations were also obtained for K ($r=.880$ $p<.005$) and for C ($r=.933$ $p<.005$) (Baillargeon & Larouche, 1991). When results are compared with foreign data (Clifford & Harms, 1989) they show a similar pattern in Quebec, thus establishing the scale as reliable in this cultural context. Interpretation for school context was taken into account during pre-experimentation and training, but as observations were restricted to school care as an environment for five-year-olds, the ECERS was deemed adequate for this specific use and for comparison with other early childhood environments such as kindergarten. Consequently, this limit should be kept in mind and results should not be interpreted as giving reliable information on school care for older children.

Children's social and language development or competencies were evaluated by means of four tests. A version of the sociogram of peer nominations (Asher, Singleton, Linsey, & Hymel, 1979) and a questionnaire on social behavior answered by the kindergarten teacher, Social Competence Scale (Kohn, 1988), translated and validated in Quebec (Bégin, Boivin, Marquis, Gervais, & Alain, 1984), were used to assess social development. Oral language was measured with a translation and adaptation validated in Quebec (Gravel, 1988; Pierre-Joly, 1978) of the Preschool Language Scale (P.L.S., Zimmerman, Steiner, & Pond, 1979), whereas written language was assessed by the Instrument de mesure de la conscience de l'écrit (Bélanger & LaBrecque, 1984), developed by a team from Quebec.

Demographic variables such as the socioeconomic level, according to the Blishen scale (Blishen, Carroll, & Moore, 1987), education of the parents, family structure, first language, and history of child care were processed as control variables or as additional descriptive information.

Results

The results focus on descriptive and comparative analyses of environmental ratings. This section is followed by a brief discussion of preliminary results on the relationship between ECERS scores and child development outcomes.

Figure 1 is a stem-and-leaf graph comparing ECERS scores of K and C environments. The raw scores appear on the figure, the lowest on top to the highest on the bottom. The "stem" or column shows the 100s while the "leaves" on each side show the units; therefore, reading the number in the stem with each number on the left gives each score yielded in K, while doing it from center to right gives it for C. For instance, on the top line, only one C had a score of 84, on the bottom line, one K had a score of 193 and one C had a score of 191. As can be seen, C environments have a lower mean (146.9) than K (164.5) ($p<.02$ on T-test) and a lower median (145 vs 172.5). Their scores have a wider range (84 to 191.5) as opposed to K (122 to 193) and a higher standard deviation (28.74 vs 21.75). Except for one score (84) standing as low as the fourth quartile or "inadequate" level, they are distributed along the second

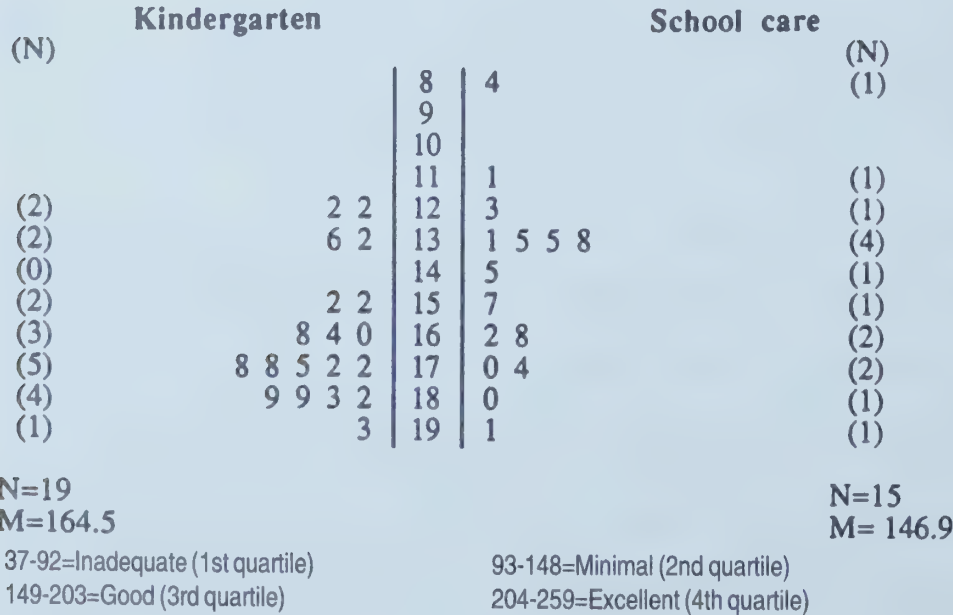


Figure 1. Comparison of kindergarten and school care on ECERS scores.

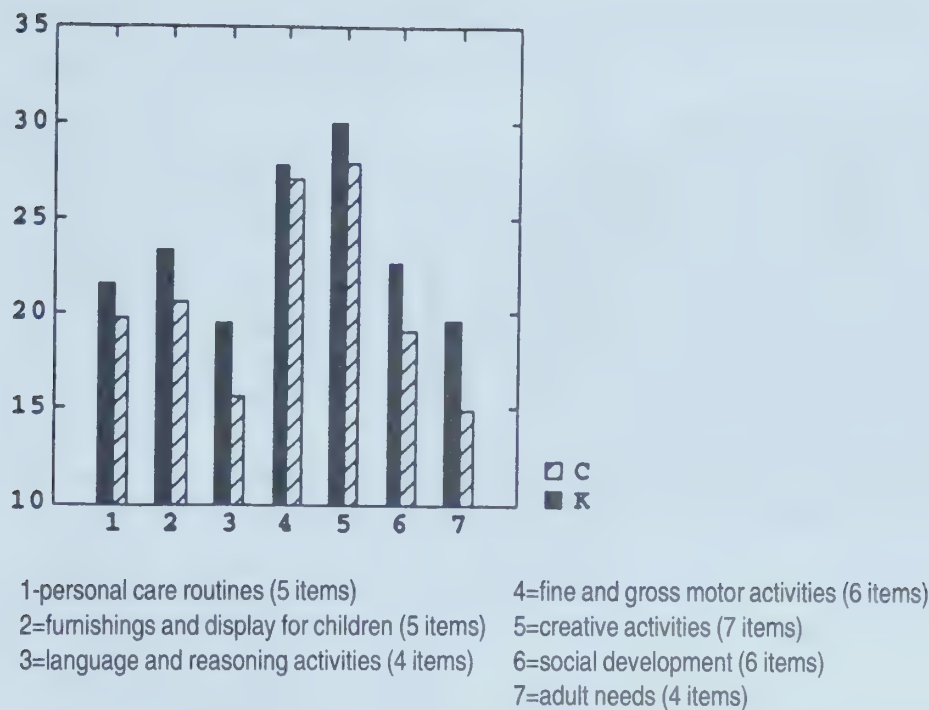


Figure 2. Comparison of school-based child care (C) and kindergarten (K) environments by ECERS subscales (on abscissa) and scores (on ordinate).

and the third quartiles or “minimal” and “good” levels of the scale, as labeled by the authors. K scores concentrate in the “good” level (15 scores or 79%) with only four of the 19 classrooms obtaining “minimal” scores.

More specific analyses compared the two types of environment on individual subscales. As illustrated in Figure 2, K obtain superior ratings on all ECERS subscales. The largest differences were found on adult needs, language and reasoning and social development subscales, whereas the lowest were seen on fine and gross motor and creative activities subscales.

In order to compare the quality of K and C settings, the ECERS ratings for each K-C pair are presented in Figure 3. As indicated, most ($n=12$) of the K classrooms had higher ECERS scores than the corresponding C environment. T-test analyses confirm this difference ($p<.002$). However, five schools showed similar ratings for both K and C environments (6, 9, 10, 14, and 15) and in two cases C settings actually had higher ratings than the corresponding K classrooms (3 and 7).

Correlation analyses obtained thus far indicate a link between the quality of kindergartens and some of the children’s measures. No relationship between C ratings on the ECERS and child development measures was found in correlation analyses. However, positive correlations were established between K scores on the ECERS and the verbal comprehension quotient of the Preschool language scale ($r=.175$ $p<.05$) and the preference score (Asher & Dodge, 1986) of the sociometric scale. In other words, children with higher verbal comprehension ability and more popular children were attending better kindergartens.

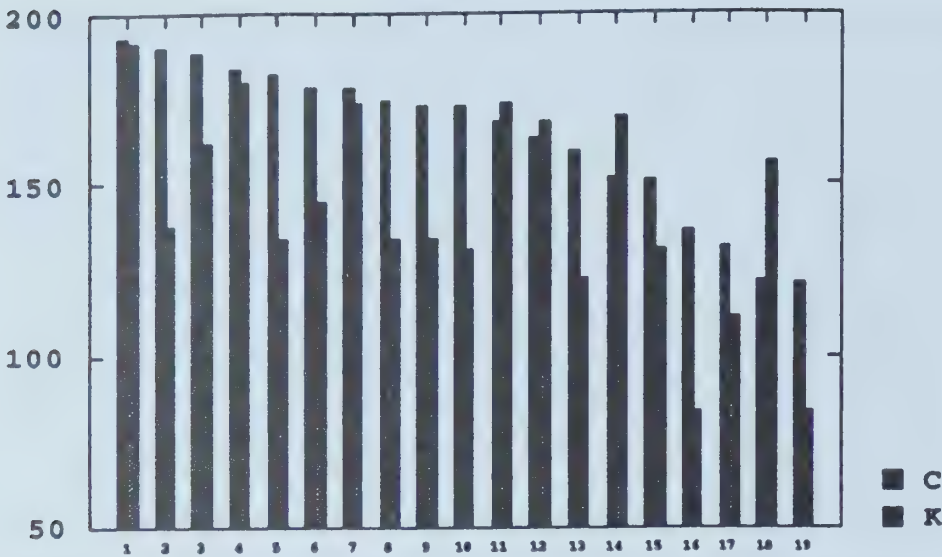


Figure 3. Comparison of ECERS scores (on ordinate) of kindergarten (K) and school-based day care (C) in same school (on abscissa).

Study Two: Educational Dialogue Between Kindergarten Teachers and School-based Educators

In a previous study, Baillargeon and Betsalel-Presser (1988) and Betsalel-Presser, Lavoie, and Jacques (1989) drew a portrait of kindergarten children coming from child care programs based on their teachers' description. For example, they described the children as being mainly autonomous, easily establishing social contact with others, yet having some difficulties concentrating, finishing a task, and following teacher's instructions. In addition they challenged the teacher by defining their own framework. Teachers expressed concern regarding discipline with this particular group of children, but they maintained that their adaptation to kindergarten was positive following the first few months. Teachers acknowledged that they had rarely delved into the children's experience from earlier programs or from the concomitant school-based day care. It became clear that both teachers and educators maintained some biased and unwarranted opinions of each other, particularly with regard to their respective roles and functions.

This study, conducted in two parts, was designed to describe the level of educational dialogue between kindergarten teachers (KT) and school-based child care educators (CE). The first part aimed to identify those factors of discontinuity that may become a risk to the child's adaptation in both settings. The second part of the study consisted of designing and applying a program of communication supported by grounded theory research methodology. This program, based on the data collected over the first year, aimed to create a dialogue between KT and CE from the same school in order to favor continuity in the child's transition from one setting to the other. The results of a questionnaire conducted in the first part of this study are presented here.

Method

Procedure

Fourteen school boards in the Montreal area were approached, and nine authorized the GIREPE team to work in their schools. Of the 116 potentially participating schools, 64 offered both K and C programs and decided to

participate. Their KT and CE received a letter requesting their participation in the study. A total of 130 questionnaires were mailed and 126 were completed.

Sample

In all, 61 KT and 65 CE responded to the questionnaire. The main criteria for selecting the sample were that the subjects had to be working in a French-speaking school where a K and a C program were offered on the same premises, have at least six K children registered in the C program, and be in contact (as a teacher or educator) with at least three children attending both programs in the school.

Instrument

As no instrument had been designed to measure the level of educational dialogue between different kinds of teachers, the members of GIREPE designed the questionnaire and submitted it to pre-test sessions with 10 KT and 10 CE. These sessions demonstrated that there was a high response level, few missing answers, and positive comments from the pre-test participants concerning the relevance of the instrument. The instrument was composed of 15 closed questions including 145 items and six open questions. For each item, the participants had four choices for an answer scaled from 1 to 4 (1=never; 2=sometimes; 3=quite often; 4=very often). Three sets of questions were then regrouped: the first referring to demographic information related to nationality, gender, age, education, and experience. The remaining questions referred to opportunities to meet with each other in school, content of communications, knowledge of the kind of experiences the child had in the other program, and knowledge of their counterpart's educational practices.

The second set of questions dealt with the participant's perception of her (all participants were women) level of relationship with her counterpart, and her level of satisfaction with the relationship, sources of information about her counterpart's program, expectations concerning the present level of communication, difficulties and obstacles establishing a dialogue, and, finally, comments and suggestions for improving their communication system.

The third set of questions looked at the participant's own educational practices with her group of children, her perception of the role of the person in the other program, and her perception of the distinctions to be made between these two environments.

Results

First Set of Questions: Demographic Data and Level of Educational Dialogue

As shown in Table 1, the demographic data offered a portrait of the KT as an older French-speaking Canadian who had a university degree in education and 17 to 36 years of experience with children. The CE was described as a rather young French-speaking Canadian, with a CEGEP (junior college degree) mainly in early childhood education, and having between one and seven years of experience with children.

From the results of the first set of questions, a score of educational dialogue was given to each participant. This resulted from the addition of the points (1 to 4) obtained by each participant from the 41 items (the few missing data were coded 1) in this first set. Thus a participant's minimum possible score was 41 and the maximum possible score was 164. These scores resulted in the forma-

Table 1
Demographic Data

<i>Teachers (KT)</i>	<i>Nationality gender and age</i>	<i>Educators (CE)</i>
100%	French-Canadian	97%
100%	Canadian-born	99%
-	23-29 years old	32%
20%	30-39 years old	45%
80%	40-56 years old	23%

<i>Teachers</i>	<i>Educational background</i>	<i>Educators</i>
76%	M.A. degree/B.Sc. ⁽¹⁾ /Certif.	31%
24%	College ⁽²⁾ /Diploma ⁽³⁾	53%
-	Grade 12	16%
18%		15%
(no answer)		(no answer)

<i>Teachers</i>	<i>Experience</i>	<i>Educators</i>
-	1 to 7 years	70%
12%	9 to 16 years	30%
88%	17 to 36 years	-

<i>Teachers</i>	<i>Employment at the same school</i>	<i>Educators</i>
27%	1 to 2 years	30%
36%	3 to 10 years	70%
38%	12 to 28 years	-

1. BSc: University degree equivalent to a minimum of 16 years of schooling.
2. College: Degree at a pre-university level, corresponding to 13-15 years of schooling. Some participants had a specialized early childhood college degree.
3. Diploma: Degree corresponding to 14-16 yrs of schooling offered up to 1970 by Quebec community colleges.

tion of three groups corresponding to three levels of educational dialogue between KT and CE each of which received a specific nomination:

level I = *acquaintance* = 41-61 pts (average variation score: 1 to 1.5)

level II = *exchange* = 62-102 pts (average variation score: 1.5 to 2.5)

level III = *collaboration* = 103-144 pts (average variation score: 2.5 to 3.5; no participant obtained an average of 3.5 to 4 points. The maximum points were then fixed at 3.5 in order to establish the three levels).

The rating ranged from 42 to 126 points for the CE and from 47 to 140 points for the KT. The majority of KT (64%) and of CE (61%) scored at level II. However, a group of about 25% of KT and 22% of CE scored at level I, and only 17% of CE and 11% of KT reached level III. These results reflect a rather limited and sporadic dialogue among the participants from the same school. It can be said, however, that a high level of agreement was found for the participants' perception of their level of dialogue. A narrow 5% deviation on the responses for both groups was observed.

A closer look at the results offers new information as to the nature of the level of educational dialogue existing between KT and CE. In relation to the opportunities to meet, they were mainly limited to the times when the children moved from K to the C programs. Eighty-five percent of the KT and 77% of the CE indicated that they used this time to talk to their colleagues.

In their exchanges they discussed children's behavior (mainly their difficulties). The least frequently addressed topics were their programs and their educational strategies. Therefore, the participants knew very little about the children's experiences in the other setting. Only 24% of them acknowledged being aware of the children's relationships with peers or with other adults, events or difficulties that may have influenced their class behavior, or the children's results for specific activities.

So it is not surprising that when the participants were asked about their knowledge of their counterpart's educational practices, fewer than 20% were aware of the level of permissiveness and the approaches used regarding specific difficulties with a child, the group's organization, or the educational practices of their colleague. These results were analyzed and matched with the demographic data presented in Table 1.

Second Set of Questions: Internal and External Factors that Affect Educational Dialogue

Concerning the obstacles to a dialogue, 77% KT and 61% CE pointed to main external factors: the incompatibility of working hours, which impedes planning of regular meetings. Because they both share the same children, participants were unavailable for meetings at a common time. Participants had to meet in their own time, since the school board would not pay for release time.

Communication between KT and CE was therefore established principally by an informal network. The child was the first source of information used by both types of participants (59% KT; 70% CE). The second most important source of information was the C coordinator (48% KT-65% CE). Finally, information was obtained directly from their counterpart for 48% of KT and 41% of CE. Hence, considering that children were the main providers of information about the other setting, one could suspect that the counterpart would probably receive a partial interpretation of the context.

The main internal factor identified as an obstacle dealt with roles and functions related to the participants' jobs. Lack of awareness of the content of activities for both programs and the educational input expected in each left the participants with a sense of ambiguity as to the scope of their role. As each group was unable to properly define the scope of their roles, feelings of insecurity were expressed regarding their professional identity. Withdrawal and defensive reactions seemed to impede establishment of a dialogue. This

obstacle was identified through the open questions as the second most important one for a healthy dialogue by most of the participants.

KT and CE seemed to share an idealized vision of their level of educational dialogue. Twenty-five percent of KT and 36% of CE believed that they had attained the highest level of communication, whereas the scores on the questionnaire indicated that only 11% of the KT and 17% of the CE had reached such a level. This tendency to idealize their self image has already been described by Abraham (1982) in her study about a teacher's inner self.

Moreover, this relatively high level of satisfaction with the present situation creates a positive feeling regarding the participant's level of communication with her colleague (78% KT and 65% CE indicated that they were satisfied or very satisfied). Thus a rather discrete majority (about 55% KT and 63% CE) really wished to get to know their colleague better, wanted to offer more information about her own milieu, and favored an increase of their present level of dialogue. However, they agreed that the child's adaptation to both programs would be facilitated by a good educational exchange, common educational practices, and better adjustment of their practices. Although educators seemed more inclined to favor a dialogue, they were more dissatisfied with the existing situation.

Third Set of Questions: Educational Practices, Roles, and Educational Dialogue

At first glance results related to the educational practices of KT and CE with their respective groups suggest that both participants have similar practices as far as educational approach, principles of regulations and assessment, motivational strategies, and ways of helping children with difficulties are concerned. Participants seemed to repeat instructions and rules clearly, making sure that they were respected. Few (20%) reported negotiating rules and instructions with the children. When they experienced difficulties, help was offered in both milieus or children were invited to ask their peers for help. Both KT and CE said they used observation and the result of children's activities as a mean to assess children's progress. However, sometimes CE did not use any kind of assessment.

Hence a deeper examination of the results on the educational approach suggested that the main differences were centered on the strategies of developing the program (only those educational practices where there was a variation of at least 20% between KT and CE were considered). For instance, most KT favored an approach where children were free to choose their own activities and the time for doing them. Most CE opted for group activities that were directed by them.

Another difference is their reactions to children's conflicts. Although both aimed to help children solve their own conflicts, KT tended to leave children on their own, whereas CE seem divided between letting the children solve their own conflicts and telling them how to solve the problems.

These results agree with those reported by Cloutier (1987) who observed that although K and preschool day care centers reported having different educational approaches, many similarities were observed between both settings, and the differences noted did not depend directly on the status of the setting. Certain factors related to the context, but materials and human resources seemed to play a larger role than the status per se.

Results indicated certain incompatibilities between the participants' perception of the role and the educational practices of their counterpart. On one hand, few CE believed that KT should favor play as a learning strategy, whereas most of KT (88%) used this. On the other hand, only 10% of KT considered that the CE's role is to observe the child, use evaluation, and refer to a specialist if needed, whereas 86% of CE stated they did this. In general, KT perceived the C program as a service that should reflect the home environment and favor free play and socialization of children. They believed that CE should plan their activities after they consult with the KT in order to avoid repetition. They also believed that CE should agree with the parents as to the educational strategies to be used.

The CE believed that KT represent the first step on the school ladder, and therefore they recognized their role of preparing the children for formal learning, providing them with appropriate cognitive learning experiences, and developing social skills.

They considered that KT should be responsible for creating a program of activities, observing, evaluating, and referring the child when necessary and agreeing with parents about the strategies to be used with their children. These descriptions made by KT and CE were identical to those presented in Cloutier's study (1987).

Discussion and Conclusion

Results of study one indicate the superiority of kindergarten over school-based day care in terms of quality of environment as measured by the ECERS. This difference stands mainly in global scores and their distribution, but it is also noted when subscale ratings are compared. These results are disturbing, especially remembering that children in double attendance remain longer in school care than in kindergarten. Unfortunately, the results are not surprising given the lack of regulation, supervision, and resources in this program. Results confirm the impression experimenters had during their observations that in too many schools, albeit not in all, the educational potential of C was undervalued. On the other hand, when both programs of the same school are compared, even if the superiority of kindergarten also shows in most of the 19 schools, in five the results are quite similar, whereas in two others the school care programs score higher. The difference in favor of kindergarten is not surprising; that in favor of C is exceptional but it can be partly explained by the low rating of four kindergartens ("minimal" level), even if three of the latter remain higher than their counterpart. In fact in some kindergartens experimenters were struck by the poor quality of the material and sometimes even of the teacher's interventions. Kindergarten is too often neglected by the school system and this can partly be seen in these results. However, 79% of K rated at the good level of the ECERS is far better than the 20% obtained in the state-wide study of Bryant et al. (1991). Moreover, in the schools where both programs had homogeneous scores, during observation a whole school atmosphere that could be responsible for that situation was felt, especially in the schools where scores were high and where the integration of less conventional activities could be seen.

Continuity in quality as defined by the ECERS remains a global and yet descriptive concept that needs to be explained otherwise. Results from study

two help explain its relationships with everyday behavior. From the start, KT and CE are shown to be different in age, education, and experience. As mentioned, kindergarten was implemented well before school care, and KT are a minority in the elementary school system. They often complain about being perceived as less important than “real” teachers. This situation could explain KT’s high sensitivity to what is often felt as competition from day care, especially from school-based day care. Other results are therefore not surprising. However, low level of educational dialogue and information, and unclear boundaries of respective roles and functions are also consequences of obstacles such as incompatibility of schedules, lack of an information network other than indirect or incidental, all shown in results from study two. In our view these results, as well as low quality of C environments, are also a consequence of unclear boundaries between their respective “official” agenda and the place given to them in both day care and school systems. Improvement is clearly needed at various levels of the systems. We believe such improvement is possible, and we hope our work will give impetus to action.

At this point in the evolution of the Quebec early childhood education system, people engaged in the field are looking at other organizations in North America, but also in Europe and especially in French-speaking countries. Their full-day kindergarten attended by children from two years of age to compulsory school and their well developed system of after-school care and school cafeterias could be as appealing as the *salles d’asile* were in the 19th century. An examination of the European early childhood systems is currently part of the ongoing debate in Quebec, although it clearly cannot be imported in its entirety.

Notes

1. Other GIREPE members involved in the Laval study are: Patricia Arenas and Johanne Desmarais, students and research assistants; Stéphanie Brassard and Marthe Deschênes-Lachance, research assistants. The Université de Montréal team also included Marie Jacques, consultant; and three research assistants, Célyne Brunet, Elise Rivest, and Johanne Phaneuf.
Two professors from Concordia University and their students, research assistants, and statisticians are also members of the GIREPE: Donna Romano-White, department of psychology and human development research center; and Ellen Vineberg-Jacobs, department of education.
2. The *salles d’asile* established in the 19th century could have changed the history of early childhood education in Quebec, but they disappeared at the beginning of the 20th century. Their existence would have been forgotten without the work of historian Dumont-Johnson (1980). It is interesting to note that the *salle d’asile* is known to be the ancestor of the French *école maternelle* and that the same name was given to the Quebec institution.

Acknowledgments

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Conceptions of Organizational Effectiveness Revisited

Adopting a theoretical elucidation perspective, this article first of all examines the various conceptions of the nature of effectiveness and of the characteristics of effective organizations. It attempts to dissipate the confusion surrounding these conceptions, to identify what distinguishes them, and to reveal the beliefs they convey as well as the reasoning they employ. The differences between the conceptions lie mainly in the way they consider the expected performance of the organization as well as the relationship between their characteristics and that performance. More fundamentally, it is the representation of the organization that underlies them. In the light of the above, the article goes on to examine the literature devoted to the effectiveness of educational organizations. The conclusion proposes an assessment of their effectiveness on the basis of performance expectations formulated by the constituents and the adoption of a revised configurational perspective in research designed to identify the characteristics of effective organizations.

Adoptant une perspective d'élucidation théorique, cet article examine d'abord les diverses conceptions de la nature de l'efficacité et des caractéristiques des organisations efficaces. Il vise à dissiper la confusion qui entoure ces conceptions, à identifier ce qui les distingue et à mettre en évidence les croyances qu'elles véhiculent ainsi que les raisonnements dont elles se servent. C'est la façon de considérer tant la performance attendue de l'organisation que le rapport entre ses caractéristiques et cette performance qui, pour une large part, distingue les conceptions. Plus fondamentalement, c'est la représentation de l'organisation qui les sous-tend. À la lumière de la démarche qui précède, l'article examine ensuite les écrits consacrés à l'efficacité des organisations d'éducation. La conclusion propose d'évaluer leur efficacité à partir des attentes de performance formulées par les constituants et d'adopter une perspective configurationnelle révisée dans les recherches visant à identifier les caractéristiques des organisations efficaces.

Theoretical inquiry comprises an aspect of elucidation that consists, among other things, in identifying the various conceptions respecting a reality or a phenomenon, in examining where they differ, in seeing to which theoretical universe they belong, and in identifying or describing the beliefs they convey and the reasoning they employ. This approach, both progressive and dialectical, not only serves to reconstruct the great theoretical universes, it also helps to dissipate the conceptual confusion that these conceptions often harbor, to grasp their implications, clarify the lines of investigation that are adopted, as well as the currents that emerge from them, improve the understanding of the reality or phenomenon in question, and even, sometimes, prepare the formulation of a standpoint.

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For those interested in organization theories, the question of organizational effectiveness remains one of the most interesting to examine. Numerous authors have studied it critically (e.g., Cameron, 1981; Cameron & Whetton, 1983; Campbell, 1977; Etzioni, 1960; Giordano, 1984; Hall, 1980; Hannan & Freeman, 1977a; Kanter & Brinkerhoff, 1981; Katz & Kahn, 1978; Scott, 1981; Steers, 1977). Nevertheless, there is still much confusion concerning current conceptions. For instance, several authors, in particular Cameron (1981), Cameron and Whetton (1983), Cunningham (1977), or Steers (1977), identify the conceptions respecting the nature of effectiveness by means of models. However, they do not always show to what reality these models refer and, in this respect, how they differ or conflict. Moreover, the beliefs conveyed by the conceptions and their underlying reasoning have not been sufficiently clarified. Finally, not enough light has been shed on how the manner of considering effectiveness in educational organizations was related to these conceptions.

In this text, I propose first of all to elucidate the conceptions of organizational effectiveness. In the first section I examine the conceptions respecting the nature of the effectiveness of organizations, and in the second section those concerning the characteristics of efficient organizations. I then address the question of the effectiveness of educational organizations. With the help of previous studies, I try to clarify the way the question is understood, examine the state of research, and suggest possibilities for development. This is the object of the third part. The discussion is restricted solely to theoretical considerations. Methodological questions are not addressed, although some are obviously of major importance.

I define organizational effectiveness, which is a social construct, as the quality of an organization that achieves the performance expected of it. By performance of an organization, I mean any effect that results from its functioning.

The Conceptions of the Nature of Effectiveness

In my view, at least five major conceptions of the nature of organizational effectiveness exist: the conception of organizational goal achievement; that of the satisfaction of functional requirements; that of the satisfaction of actors associated with the organization; the exogenous conception; and the conception that sees effectiveness as a capability. A study of these five conceptions leads me to propose a conception that defines effectiveness on the basis of the performance expected by the organization's constituents.

The Conception of Organizational Goal Achievement

Effectiveness is defined here as the degree of achievement of the goals adopted by the organization (e.g., Price, 1968; Van de Ven & Ferry, 1980) under certain conditions (Etzioni, 1960, 1964). Goals, understood as the intention to achieve results that determine the organizational action, thus express the performance expected of the organization.

In a profit seeking perspective—adapted when necessary to nonprofit organizations—and in accordance with its logic, the conception has been operationalized with the help, mostly, of efficiency-related criteria. These refer either to the way of using resources or to the achievement of optimal perfor-

mance, such as profit, productivity, return on investment, and so forth. Often the efficiency itself is used as a criterion.

Reservations concerning this first conception of effectiveness are numerous and of several kinds (e.g., Campbell, 1977; Etzioni, 1960, 1964; Hall, 1980; Hannan & Freeman, 1977a; Kanter & Brinkerhoff, 1981; Perrow, 1961; Pfeffer, 1977). Some of these apparently lie at a purely technical level. For example, the organization may have several goals, or they may be hard to formulate other than in a vague, general, or abstract way. Other reservations reveal the incongruity of the conception as regards the reality of the organization's dynamics. For instance, the difference is noted between the officially announced goals that aim to satisfy actors of the environment or the organization, and those actually pursued by the organization (Perrow, 1961). This raises the double question: What goals are involved and whose goals are they? Also noted is the lack of coherence reflected in the activity of the subunits compared with the goals pursued; the shift in goals as a result of the activity of certain groups; the conflictual character of the goals; and the change of goals due in particular to the modification of environmental factors.

Prescriptions for rational management are intended as responses to many of the problems invoked, especially those of a technical order. The responses applied to the other difficulties are multiple. Some authors (e.g., Perrow, 1961; Price, 1968; Steers, 1977) advocate evaluating the operative and operational goals, that is, those that translate what the organization is really trying to do in its activities, and which are conveyed by the principal decision makers, independently of the formal goals. On the other hand, other authors, such as Campbell (1977) or Van de Ven and Ferry (1980) consider that the assessment of effectiveness requires the formulation of a judgment on what constitutes an organization's goals and the conditions that must be respected in order to achieve them. Finally, other conceptions of effectiveness are proposed.

However, what is really at the root of the reservations expressed with regard to this conception of effectiveness is the underlying mechanistic or closed system representation of both organization and goals (Scott, 1981). Thus the organization is seen as an entity rationally structured in order to achieve the goals ascribed to it. These goals are conceived in the same way as the function of an instrument or a machine: they are inherent in the organization. Henceforth the organization once constituted possesses and pursues goals that ensure its functional unity. It exists independently of the actors who have created it and evolve in it. It is endowed in a way with its own impersonal rationality. It is, so to speak, hypostasized or, as Silverman (1970) puts it, reified.

Furthermore, concerning the criteria of effectiveness, two comments must be made immediately, which also apply to the other conceptions. The authors do not dwell much on showing how the criteria for assessing effectiveness are related to their conception of it (e.g., Katz & Kahn, 1978; Price, 1968; Scott, 1981; Steers, 1977). Even those who study the criteria more closely, in particular Campbell (1977), Price (1968), and Steers (1977), say nothing about this problem, although they stress the diversity of the conceptions reflected by the choice of criteria. In this respect, the reader must often wonder whether by the use of the word *criterion* an author is referring to dimensions of effectiveness,

to a principle or norm that permits its establishment, or to an indicator of the latter.

The need to compare the performance of organizations or to identify the characteristics of those that are effective has elicited the prior identification of effectiveness criteria valid for all organizations or for a type of organization (e.g., Price, 1968; Etzioni, 1960). This practice has at least two consequences. First, the representation of the organization endowed with an inherent rationality is reinforced. Second, the criteria become requirements that are imposed on the organization independently of the actors that give it its aims. The criteria retained must therefore define the performance that the organization must achieve. Recourse to "universal" criteria thus helps to change the initial perspective. The performance that the organization must achieve in order to be effective is no longer the one that stems from its goals but the one that any organization—or organizations—of the same type must necessarily achieve. Such an approach becomes obvious in the following conception.

The Conception of the Satisfaction of Functional Requirements

Apart from the problems already mentioned, the conception related to goal achievement and the criteria first retained have also proved insufficient for another reason raised by both Georgopoulos and Tannenbaum (1957) and Etzioni (1960; 1964). Indeed, these authors emphasize that goal achievement is linked to a set of conditions that affect the organization's ability to achieve them in the long term and survive. Consequently, in their view, the assessment of an organization's effectiveness must take these conditions into account.

The proponents of the human needs related (HNR) approach have thus focused on the conditions related to the organization's state of functioning (or processes) and the effects it produces on individuals. This concern stems from the logic of the organization's representation that characterizes the approach and under which I group the human relations perspective as well as the wider view that tries to reconcile the organization's requirements with the needs of the individual. In this conception the organization is seen as a system structured for the purpose of achieving common goals. The idea of a natural body or system (Scott, 1981) replaces that of a machine, and internal equilibrium becomes predominant.

The criteria retained in the previous conception are thus complemented by criteria such as personal satisfaction or morale, the state of tension or the climate (Friedlander & Pickle, 1968; Georgopoulos & Tannenbaum, 1957; Halpin & Croft, 1963; Price, 1968). Under the impetus of the organizational development movement, effectiveness has been gradually more or less assimilated to the organization's state of health (e.g., Beckhard, 1969; Bennis, 1966; Miles, 1965). With the help of such a conception, the authors wish to account for an organization's state of functioning, as well as its prospects for survival and development. They invoke a set of properties one of which concerns goal achievement and certain others that are already concerned with the organization's relations with the environment.

Indeed, as the organization has come to be seen as an open, natural system in constant interaction with its environment, effectiveness has also been linked to conditions related to this interaction. These concern the organization's

ability to conserve its legitimacy regarding the environment and to acquire the resources it needs to operate. Consequently, to be effective, in other words to survive, the organization depends on the function it plays in the environment and the impact it has on it. It must also adjust to the constant changes that occur there.

Effectiveness is here defined in terms of the requirements that the organization must satisfy in order to continue to exist (e.g., Argyris, 1964; Harrison, 1987; Katz & Kahn, 1978), one of these being the achievement of goals. These goals express the organization's contribution to the social system to which it belongs and that forms its environment (Katz & Kahn, 1978; Parsons, 1960). While promoting this conception, structural functionalism also provides a frame of reference for organizing its representation (e.g., Parsons, 1964; Selznick, 1948). Within this frame, the most common requirements are goal achievement, efficiency, maintenance in a state of equilibrium both internally and as regards the environment in a short- and long-term perspective, and adjustment to environmental changes. This approach is one of those corresponding to the system model and figuring in most of the trends that form situational theory.

According to this conception, the phenomena of change or goal shifts appear as the organization's adjustment mechanisms that enable it to continue to maintain itself in a state of equilibrium, that is, to survive, and even to develop. It is not so much the achievement of such goals that is important but the survival, which of course implies the accomplishment of a performance.

Still, according to the conception, the factor that characterizes the nature of effectiveness is no longer the performance expected or desired from the organization, but the performance that should be expected or desired. This is established on the basis of requirements that are considered as inherent in the organization and independent of the actors' intentions. They form a preexisting normative model to which the organization must conform in order to survive. Moreover, an organization's effectiveness is henceforth assimilated or confused with its survival. In short, the reality to which the conception of effectiveness refers is radically modified as regards the first conception.

Such an approach means that organizations would be, on the one hand, destined to achieve other purposes than those to which the social actors want to make them serve and under conditions that they do not necessarily choose. It is implicitly equivalent to transforming choices that stem from the values and ideology of social actors, strongly legitimized in our societies, into norms to which all organizations must conform. Why should an organization's level of performance be optimal if it is not by choice and, in particular, very frequently a choice that conveys the ideology of necessary progress? And why should the resources be used as well as possible if not by economic, ecological, or social choice? Similarly, why talk about an organization's survival or its necessary adjustment if this is not because social actors wish it to be the case?

The nature of the choices that define the organization's expected performance is thus challenged. In my view, this is something quite different from effectiveness unless an effective organization is defined as an organization capable of achieving everything that can possibly be expected of it, whatever the content of the expectations and the conditions of their fulfillment.

This approach also places on the same footing expected performance, conditions to be respected for its accomplishment, and sometimes conditions to be met in order to achieve it (Campbell, 1977; Pennings & Goodman, 1977). In short, a frame of reference allowing the organizational actors to better identify or anticipate the different problems they may have to face and the constraints that they must take into account in the fulfillment of their expectations becomes what the organization is committed to satisfy.

The conception of functional requirements, formulated in the HNR (human needs related) and situational theories, reproduces the representation of the organization and the goals underlying the previous conception of effectiveness, in spite of the major differences specific to each theory. The organization is still represented in it as an entity existing in itself and structured to achieve its goals.

As mentioned above, the conception is also based on a normative representation of the organization and thus lies at a purely hypothetical level. Indeed, it does not take account of the reality of organizations, in particular the fact that the requirements they must face are frequently conflictual. In this regard, we must recognize the nuances that authors such as Argyris (1964) and Katz and Kahn (1978) bring to the formulation of their respective positions.

Finally, like several authors (Crozier & Friedberg, 1977; Etzioni, 1964; Hannan & Freeman, 1977a), it should be noted that the assimilation of effectiveness to survival is not automatic. Certain authors (e.g., Crozier & Friedberg, 1977) emphasize, moreover, that ineffective organizations do continue to exist. Furthermore, survival only sometimes emerges as a condition that the achievement of an expected performance must respect, while at other times it becomes the object of the expectations entertained with respect to an organization (Mintzberg, 1983).

The Conception of Participants' Satisfaction

According to a third conception, an organization is effective insofar as it meets the expectations of actors associated with it in one way or another and who try by this means to promote their objectives and interests. According to the authors, either such expectations determine the performance that the organization must achieve, or they become more or less pressing requirements to which the organization must respond if it wishes to continue to exist.

This conception of effectiveness is more or less directly inspired from a theoretical perspective that goes back at least to Cyert and March (1963). It sees organizations as coalitions of participants who seek to satisfy their interests, which may be different and incompatible. The performance pursued by the organization testifies to what the actors agree about.

At least three versions of this conception are known. The first groups authors who define the performance to be achieved on the basis of the expectations of multiple participants. Simultaneously, they retain a criterion of effectiveness, a metacriterion, according to Keely (1988) or Zammuto (1982), valid for any organization. Thus Cummings (1977) adopts a psychological perspective and says that an organization is effective insofar as the majority of those participating in it perceive that they can use it to satisfy their interests. Zammuto (1982) adopts a more evolutionist perspective and formulates the criterion of social legitimacy. The effective organization is one that satisfies the

participants' changing expectations by succeeding simultaneously in acting on the constraints that affect it and that are also changing. Keeley (1988), who adopts a social justice perspective, thinks an organization is effective insofar as it minimizes the wrongs done to the different participants.

A second group of authors is more interested in the strategic participants, that is, those who have a significant influence on the organization. Placing themselves in the ecological theory of organizations and agreeing with the position of Yutchman and Seashore (1967), Pfeffer and Salancik (1978; Pfeffer, 1977; Tsui, 1990) consider that effectiveness consists in satisfying the expectations of the actors who agree to support the organization and who influence its ability to obtain the resources it needs and to conserve its legitimacy. Goodman and Pennings (1980) and Pennings and Goodman (1977) adopting a position that is close to that of Perrow (1961), consider for their part that the expectations the organization tries to satisfy are more likely to be determined by the dominant coalition. This is formed by the actors who entertain a fairly direct link with the input/output processing. Through an ongoing process of negotiation, considering each individual's constraints and abilities, these actors succeed in imperatively defining the organization's goals and in choosing the means to achieve them. The dominant coalition thus succeeds in fixing the criterion of effectiveness.

The last version of this conceptual theme is proposed by Connally, Conlon, and Deutsch (1980). This is a relativist position in which an organization's effectiveness is evaluated in terms of the expectations of each group of strategic actors.

Whether it is a question of effectiveness viewed from an expected performance or effectiveness assimilated with survival, the so-called participants' satisfaction conception establishes that the organization's performance must be evaluated with reference to the expectations of actors associated with the organization and not with reference to the organization's inherent requirements. It thus comes down to the assertion of an organizational intentionality attributable to the actors. In addition, it draws attention to the influences the actors exert in the organization's decision making processes and the implementation of their choices so that their interests and objectives are satisfied.

However, as Chanlat and Séguin (1987) point out, most of the proponents of this trend do not question common organizational intentionality considered as a normal conclusion of the influence processes and on which the organization's functional unity is based. A few authors, such as Zammuto (1982), take account of the irreconcilable expectations and constraints to which organizations are subjected. Opting for an ultimate criterion of effectiveness, a metacriterion, which is a way of solving the problem of divergent expectations, several authors tend rather to predefine the performance to be expected from the organization. Moreover, rather than identify the actors who make the decisions at the origin of the organization's constitution and form its intentionality, this trend mainly focuses on the expectations that are expressed or that should be expressed in the process of making these choices and which the actors take or should take into account. Last, the conception of Pennings and Goodman (1977) focuses more on the choices that certain actors succeed in promoting in the course of organizational functioning rather than the choices

themselves, which were in one way or another supposed to be at the origin of the implementation of means to which the functioning testifies, just as if the problem of effectiveness was not to ensure that the means satisfy the intention.

The Exogenous Conception

Beside the conceptions described above, Giordano (1984) points out that there are also exogenous conceptions of effectiveness. Their reference model consists in ways of doing things that are external to the organization, to which the latter must conform and which thus become the criterion of their effectiveness. This is the case with accountancy rules, laws, regulations, and so forth.

This conception of effectiveness agrees partly with the institutional theory developed in particular by Meyer and Rowan (1977, 1978). On examination, it will be noted that it recalls the requirements that organizations in the accomplishment of their mission must satisfy in order to continue to exist and that are imposed by external groups of actors or by a whole community. Thus it is fairly similar to the previous conception. However, it should be noted that the requirements to which it refers mainly concern organizational functioning.

The Conception of Effectiveness as Capability

Certain authors define effectiveness as the organization's capability to achieve the performance expected of it or to satisfy either functional requirements or those of actors who condition its survival. This definition seems to produce a certain confusion that Etzioni (1960), in my view, helped to create by using the term *system model*. Indeed, this way of defining effectiveness sometimes refers to the performance either expected or that should be expected of the organization (e.g., Pfeffer & Salancik, 1978). Sometimes it refers to the characteristics of the model that the organization must possess in order to achieve a given performance (e.g., Steers, 1977; Van de Ven & Ferry, 1980). In this case, effectiveness is really a capability, and its assessment consists in establishing whether the model possesses the desired characteristics. However, this last approach seems to interfere with the question of the characteristics of effective organizations, the subject of the second part. Sometimes, what the authors are referring to is not clear (e.g., Beckhard, 1969; Miles, 1980; Yutchman & Seashore, 1967). The term *system model* is a good illustration of the possible confusion. Some authors (Cameron, 1986; Lewin & Minton, 1986) do not hesitate, moreover, to refute the usefulness of a distinction between indicators and predictors of effectiveness, the latter often being taken for the former and vice versa.

Whatever the difficulties created by this conception, in the final analysis it is still based on a reference to organizational performance. Indeed, the conviction that an organizational model is capable of producing a given performance assumes that at one moment or another this has been identified from the assessment of a certain performance. However, it must also be mentioned that this conviction often conceals another certainty—that an effective model has the capability of producing all types of performance whatever their conditions of achievement.

The Conception of Performance Expected by the Constituents

In its primary meaning, effectiveness is the quality attributed to a means or instrument that achieves the performance expected of it in a given context

under certain conditions. In accordance with this sense, which in my view should be retained, I consider an organization's effectiveness must be defined in terms of what it is destined for, that is, in terms of the performance its participants expect of it.

Viewing an organization as a contingent social production, I define it as a social entity constituted (i.e., created or maintained and structured) by actors in order to serve as an instrument for the fulfillment of intentions or goals that are the expression of objectives that they wish to achieve, interests that they wish to promote, or needs they wish to see satisfied. What an organization must serve for lies essentially in these intentions. The actors who, on their own behalf or that of other actors, constitute an organization, I call constituents. It is they who determine its intentionality and who create the impetus that commands the implementation of the means. They dispose of the organization's existence and orientation. They are its owners or exercise the latter's prerogatives.

In other words, through their position in the organizational production process and through their abilities, certain actors define the goals that the organization of which they are the constituents must serve, these goals that are theirs becoming, as Thompson (1967) puts it, the goals of the organization. To achieve them, these same actors also promote the use of various resources and the contribution of other actors, it being understood that the latter contribute to the organization in order to serve their own interests and objectives.

The conception proposed here does not consider that organizations have goals. It does not assume that the purposes the organization must serve are common to the actors, or that the latter view them in the same way. It does not imply that these purposes are set once and for all, or that they do not change, because the function of constituting the organization is exercised as long as the latter lasts. Neither does it take for granted that the constituents act according to a single and shared rationality, particularly in the process of implementing their intentions, or that the actors who contribute to the implementation necessarily seek the achievement of these purposes. Rather, the issue it raises is what effectiveness represents within an organization: to ensure that the performance expected by the constituents is achieved. In this regard, the conception proposed here, although close to those of Perrow (1961) or Pennings and Goodman (1977), differs on a fundamental point that relates to the fact that, according to the latter, the intentionality of the organization corresponds to the intentionality that actually operates within the organization.

Finally, the proposed conception does not eliminate the problems sometimes posed by the identification of the constituents' intentions. In many cases, the assessment of effectiveness may be only approximate, if not misleading or impossible, because one of the terms of the comparison is missing.

In concluding this first part, I retain a conception that defines effectiveness with reference to the performance that its constituents expect of it. Let us now take a look at conceptions relating to the characteristics of effective organizations.

The Characteristics of Effective Organizations

The study of the characteristics of effective organizations seeks to explain the effectiveness or to predict it. It is also prompted by the desire to find the model or models that are likely to make organizations effective.

There are at least three ways of responding to these concerns: the mechanistic approach, the HNR approach, and the situational approach. Each gives rise to a manner of conceiving the organizational model. Each assumes that the organization possesses appropriate resources, both qualitatively and quantitatively, especially as far as technology and technical systems are concerned. They differ in their view of the utilization of resources, especially human resources, in their identification of the elements or components of significant importance in the model and in their way of viewing the relationships between these elements.

The Mechanistic and Human Needs Related Approaches

The mechanistic approach asserts, first, that in order to be effective an organization must possess a rational structure and management model so that the organization functions like a machine. Such a model must make the functioning of the organization entirely predictable. It stipulates that individuals, that is, the employees, must be used like the parts of a machine. Second, the approach claims that its premises that lead, for instance, to a bureaucratic type of model as described by Weber (1971) or the mechanistic model identified by Burns and Stalker (1961), are more or less in line with the requirements of the first assertion.

The HNR (human needs related) approach considers for its part that the mechanistic model is intrinsically ineffective because its conception of the use of individuals denies the human needs that cannot not be taken into account (Argyris, 1964). It starts by asserting that the organizational model must reconcile the requirements of both the organization and its members. Second, it maintains that the set of stipulations advanced by its proponents responds more or less to the principle of the first assertion. This set of stipulations corresponds with the organic model of Burns and Stalker (1961), the management principles of Likert (1961) and his system 4, or even with the principles of Peters and Waterman (1982). The model of Hackman and Oldham (1980), although more restricted, adopts similar lines. It should be noted that as regards the mechanistic stipulations, this approach attaches great importance to the state of relations between individuals as well as to the processes that involve them and to the individuals' attitudes toward the different aspects of the organization and their contribution to it.

The two approaches conclude that in order to be effective an organization must adopt the model that stems from their respective stipulations. It will thus be noted that they are both inspired by the same type of reasoning, the difference between the two concerning the content of the propositions or the proposed model, the model of the first approach being opposed to the model of the second. In each case, the reasoning results in proposing a single ideal model valid for all organizations. It is the "one best way" conviction.

The Situational Approach

The situational approach contributes a third type of response that claims to break with the one best way. In this approach at least three trends can be noted. Each, using the systems approach, although in a different way, gives rise to a so-called system model.

The first trend, whose inspiration goes back at least to Burns and Stalker (1961) and Woodward (1965), is that of structural contingency (Lawrence & Lorsch, 1969; Lorsch & Morse, 1974) and situational management (e.g., Hersey & Blanchard, 1969). It postulates that no single model is able to guarantee the effectiveness of all organizations. For an organization to be effective, its model must be adapted to the factors that compose its situation.

This theory presents only a somewhat superficial challenge to the one best way theory. Indeed, it postulates that there is a valid, one-best-way model for each type of situation no matter what performance is expected of the organization.

The deterministic reasoning proposed by the mechanistic, HNR, and structural contingency approaches or by the situational management approach thus leads to the same position: an organization is effective if its model corresponds to a model that is either ideal in itself or with regard to a typical situation, no matter what the organizational intentions, provided, of course, that these intentions are stated and sought according to the premises of the model and that the organization possesses the appropriate resources.

While proceeding naturally from the previous trend, the second trend of the situational concept, that of configuration theory (Khandwalla, 1973, 1977; Miller & Friesen, 1984; Mintzberg, 1979), takes the application of the propositions of systems theory to its limit. Indeed, rather than consider only one or more factors and only see the relationship between the types of variables in a linear fashion, configuration theory focuses on the whole set of elements that form the organizational framework. It postulates that the relations between these relations operate in all directions. Mintzberg (1979) formulates the basic principle of the effective organization as follows: "effective structuring requires a consistency among the design parameters and contingency factors" (p. 220).

The configuration argument is just as deterministic as the previous approaches. Indeed, in my view, it appears to postulate that consistency between the elements in the whole organization is equivalent to their maximum adjustment, which necessarily stems from characteristics inherent in each in their relations with the others and to the whole (Mintzberg, 1979). Thus for each set of elements there would be an ideal and autonomous configuration, a winning combination that has, of course, to be identified or discovered. As regards the approaches examined so far, it is no surprise that in the eyes of Hannan and Freeman (1977a) the question of effectiveness is essentially related to an engineering perspective.

However, unlike the previous approaches, the very logic of configuration theory assumes that the expected performance is part of the configuration. Thus the organizational model also depends on expected performance and the consistency principle applies to it. In short, the model that makes an organiza-

tion effective cannot be considered separately from the performance expected of it.

According to the third trend of the situational approach, the ecological trend (e.g., Aldrich, 1979; Astley, 1985; Hannan & Freeman, 1977b, 1989; McKelvey & Aldrich, 1983), a configuration is a model that emerges in a group of organizations associated with a basic technology in a given situation for a given time. The model develops little by little and in a more or less differentiated manner within this group of organizations, concurrently with improvements in the basic technology. In a rare resource context, the form the model assumes in certain organizations enables them to survive. It thus makes these organizations effective.

Survival might be explained by the consistency principle as it is understood in the previous trend, and the two trends are convergent. However, the theory authorizes another interpretation that, to my knowledge, is not mentioned by its proponents. If organizations survive, it is because their model enables them to respond satisfactorily to the most important problems and requirements that confront them. Such a capability does not, however, imply that the organization forms a coherent whole where there would be no contradiction or dysfunction, nor that the prevailing configuration is the only one that enables these organizations to respond satisfactorily to the requirements of their situation, nor that another configuration would not permit a better response.

This interpretation cannot ignore the fact that there is a tendency in organizations of the same family to adopt the same configuration. According to ecological theory (Astley, 1985) this is probably because these organizations are in constant interaction, so that some borrow from others that are deemed to perform better. But as suggested to me in a different way by the theories of Boudon (1977), Crozier and Friedberg (1977) and Silverman (1970), there is another reason too. The environment in which the organization is constituted and evolves, like the combination of the elements that help to constitute it thus making its activity possible, represent a whole range of both possibilities and constraints that delimit the range of the forms the organization can take. These elements influence the form of the organization in the sense that they impose or delimit the definitions that the actors give to the organizational situation and the responses to which these actors have recourse or adopt. As acknowledged by Crozier and Friedberg (1977) there exists a certain pregnancy of the elements that compose the organizational situation.

Among these elements, I retain five that I consider especially pertinent and that partly overlap.

- The technology (or technologies) that is itself a solution invented to solve a type of problem and that implies a certain representation of the expected performance;
- The cultural and institutional factors that provide the actors with ways of defining situations and responding to them;
- The way the actors define their link with the organization as a whole and with each of its aspects as well as their relations with the other actors, which includes their intentions and, as put by Lorsch and Morse (1974), their fundamental predispositions;

- The models generally admitted in a society that concern the way certain actors can constrain others or the way the former can use the latter's contribution and the margin of maneuver at their disposal in this regard;
- The history, that is, past functioning as a factor for structuring present functioning.

This manner of understanding the configurations leads me to draw the following conclusions:

- Research concerning the characteristics of effective organizations should be conducted in a configurational perspective;
- This perspective includes the characteristics of the organization's expected performance;
- The configuration specific to a group of organizations is only applicable to other organizations if the latter's situation is approximately similar to that of the former;
- Capturing the characteristics of a configuration is never easy, especially when it is in the process of development;
- Insofar as survival and effectiveness cannot be assimilated, it would be desirable to find out what, in a group of organizations whose model is satisfactory, enables some of these organizations to perform better than others.

In short, this study devoted to the conceptions respecting the factors that characterize effective organizations reveals the following: the conceptions differ, among other things, in terms of the convictions they entertain respecting the one best way, the place of the expected performance of the organization in the model, and the nature of the relations that are established between the elements in it.

The Effectiveness of Educational Organizations

The literature devoted to educational organization mostly reproduces the way the question is treated in the whole range of publications on effectiveness. They focus especially on institutions at the primary and secondary level. What distinguishes them most significantly is, first, the issue introduced by the conclusions of the studies of Coleman et al. (1966) and Jencks et al. (1972). Addressing the question of student achievement from the standpoint of the input/output relationship, these studies reveal the crucial influence of the students' socioeconomic characteristics on academic attainment and the rather small influence of other factors (Trottier, 1981). Although subjected to numerous criticisms (e.g., Collard, 1984; Trottier, 1981), they nonetheless undermine a number of previously held beliefs respecting the factors that influence the performance of schools. In particular, by minimizing the school effect, that is, the impact of the school's specific model on that performance, they challenge a basic premise of the management sciences and organization theories, namely, that the characteristics of the model do make a difference in performance.

It is easy to understand the ensuing effort not only to establish the influence of certain factors on the performance of schools, especially that of teachers and educational intervention technology (Bossert, 1988; Clark, Lotto, & McCarthy, 1980; Collard, 1984; Murphy, Weil, Hallinger, & Mitman, 1985; Rosenholtz, 1985), but also to capture this school effect. To paraphrase Rutter, Maughan,

Mortimore, and Ouston (1979), can children spend 15,000 hours at school without it making a difference? Among the research characterized by the trend that has focused on the school effect, which during the 1970s we should note in particular that of Brookover, Beady, Flood, Schweitzer, and Wisenbaker (1979), Edmonds (1979), of course that of Rutter et al. (1979) and G. Weber (1971). On the basis of these studies, the belief in a school effect has been rehabilitated. At the same time, concerns turned to the identification of characteristics associated with "effective" schools. An inquiry to which I contributed is characterized by this approach (Brunet, Brassard, & Corriveau, 1991).

In spite of lack of consensus in the literature concerning the nature of effectiveness, and in spite of the fact that most authors deplore the fact that the goals of educational institutions remain vague, and in spite of the problems of all kinds that it raises, the criterion of student achievement is easily acknowledged as best accounting for the schools' performance. If it is retained, it is because it refers to teaching objectives that are deemed essential for all schools. In certain research projects, some additional criteria are mentioned relating to the students, in particular their social behavior (Rutter et al., 1979), the self-image they develop (Brookover et al., 1979; Montmarquette, Houle, Crespo, & Mahseredjian, 1983), their attitudes to the school (Miskell, McDonald, & Bloom, 1983; Smith, 1975) or their problem solving ability (Brookover et al., 1979). Finally, others complete the picture with criteria dealing with functional requirements, in particular the climate or the satisfaction of the members of the organization (e.g., Firestone & Herriott, 1982; Miskell et al., 1983; Smith, 1975). More recently, dropping out has also become a phenomenon associated with organizational performance, which may be explained in part by the school effect (Bryk & Thum, 1989; Fetler, 1989, Wehlage & Rutter, 1966). Few studies use a conception that fits the trend of participants' satisfaction, although certain noteworthy exceptions include Goodlad (1984) and for institutions of higher learning Bresser and Dunban (1986) and Cameron (1981).

In brief, the principal criterion retained reflects a type of objective deemed by the researchers essential to the school. It is a limited criterion that does not take account of aspects of performance expected by the constituents and that tends to overlook the students' development objectives (Rossman, Corbett, & Firestone, 1988).

As regards the characteristics of effective schools, the research findings agree to a fair degree (Bossert, 1988; Purkey & Smith, 1983; Rosenholtz, 1985; Rowan, Raudenbush, & Kang, 1991), in spite of sometimes quite considerable differences. They form a whole that corresponds to the organic model of the HNR approach. Regarding the past acquisitions of this approach, the findings thus contribute nothing new. However, they do highlight the fact that the social processes and referents that predominate in the school impact on students' behavior, thus conditioning student achievement. Interpreted in a situational perspective, the findings tend to confirm the belief that for educational organizations it is this model that ensures effectiveness (Rowan et al., 1991). Such a belief must obviously take for granted that all educational organizations form a same type where the same basic characteristics are to be found. It fits in with the approach that maintains that an organizational model

adapted to the situation shared by organizations makes the latter effective, no matter what performance is expected of them. To be truthful, I do not believe that any further investigations in this direction will contribute much more to what we already know.

Over the last 10 years, two trends have emerged. The first consists in making a clearer distinction between the types of variable in order to get a better picture of how they interact and how they affect the schools' performance (Bossert, 1988). Three groups of variables are identified: first, the organization and the functioning of educational interventions, including the students' progress structure and teaching practices (educational technology); second, management behavior, especially behaviors more directly related to educational interventions compared with those respecting management in general; and, third, the organization and the general functioning of the school including its norms and value system.

Concurrently, a second, more situational trend is emerging where the organizational model is studied by taking into account the different structural levels constituting the organization of teaching. This is the multilevel perspective (Bossert, 1988; Bryk & Raudenbush, 1988; Murphy et al., 1985; Rowan et al., 1991). This approach also retains as variables not only the characteristics of educational technology and the teachers' attitudes (see Rowan, 1990), but also the institutional characteristics (Meyer & Rowan, 1977; Bryk & Driscoll, 1988; see Rowan, 1990). The direction taken by Rowan et al. (1991), which consists in identifying the factors affecting the implantation of the organic model and which should therefore help to reveal the characteristics of the situation to which this model is applicable, also fits into this movement.

However, these trends do not take account of the expected performance of schools, with at least two exceptions: Rosenholtz (1985) and Rowan (1990). Moreover, with the latter's article entitled "Commitment and Control: Alternative Strategies for the Organizational Design of Schools," a new development emerges that corresponds with the configurational perspective.

Following Bidwell (1965), authors had tended until recently to define educational organizations as organizations of professionals forming loosely coupled systems (Weick, 1976) that comprise, in particular, ill-defined goals, an uncertain technology, and fluid participation (Brassard, 1987; Rowan, 1990; Rosenholtz, 1985).

This representation, which prevailed for a long time, was based far more on what I believe to be an artisanal-type of approach to educational intervention and on a unitary conception of society where the schools' expected performance was taken for granted. What is revealed by Rosenholtz (1985) and Rowan (1990; see also Brassard, 1990) is the modification of this representation under the impetus of the educational reforms undertaken during the 1970s and that advocate greater mastery of educational intervention through a precise and explicit formulation of the teaching objectives.

Rowan (1990) identifies two models that are developed in association with two representations of educational technology and appear as strategies to improve the schools' effectiveness. The first model, called control strategy, comprises a thorough description of the teaching programs that become compulsory, a standardized control of student achievement, evaluation of teach-

ers, and inservice training programs in effective teaching practices. The second model, which is intended as a teacher commitment strategy, sees teaching as a problem solving activity in the complex situation of the classroom.

Rowan's (1990) study is limited to a few elements and takes account of only two conceptions of educational technology. Nonetheless, this approach paves the way to a doubtless complex, but probably fruitful, research approach. Apart from the above mentioned variables, such an approach must, of course, include the students' characteristics, which from a control variable would become an element of the configuration. Nor should it overlook the way the different actors of the school define the situation. This is the approach adopted by Patty (1981) in a study of 12 French schools.

Conclusion

The manner of considering the expected performance of organizations, like that of considering the relationship between the latter and the organizations' characteristics, lies at the heart of what distinguishes conceptions of effectiveness. More fundamentally, the differences are explained by the representation of the organization that they convey.

The discussion concerning the nature of effectiveness and a political representation of the organization has led me to opt for a conception that defines effectiveness on the basis of the performance expected of the organization by its constituents. Such an approach, applied to research on educational organizations, assumes changes in the manner of assessing their effectiveness. In particular, it assumes assessing their performance in relation to the whole set of expectations that the constituents wish to see satisfied. The assessment of effectiveness will probably become more complex. Nonetheless, as an effect of the assessment the approach will have the advantage of encouraging clarification of the purposes for which the constituents destine their organization in relation to its ability to achieve them and to prompt a more circumscribed questioning about them. It will also have the advantage of drawing attention to the mechanisms whereby the constituents try to implement their intentions.

As regards the relation between the organizational model and effectiveness, I opt for a configurational approach where the organization's expected performance and the characteristics of its model are closely associated, the former counting among the components of the latter. Read in the light of an interpretation of ecological theory suggested by theories described by Boudon (1977) as interactionist, this approach leaves the absolute or relativist one best way and distances itself from a certain determinism entertained by a normative representation of the organization. Moreover, it rejects a representation of it, which in my view is incompatible with an intentionality attributable to the actors.

With respect to the research on the effectiveness of educational organizations, this revised configurational approach should provide a better understanding of the changes that occur and the models that are in the process of being developed, provided, as we have pointed out, that the students' characteristics and the definitions that the actors maintain of the organizational situation are taken into account.

Note

1. Among the authors who have made a more or less extensive study of this literature since 1980 are Bossert (1988), Brunet et al. (1991), Collard (1984), Purkey and Smith (1983), Rosenholtz (1985), Rowan et al. (1991), Séguin (1987), and Trottier (1981).

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